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ELEMENTS
OF
CHEMISTRY:
COMPREHENDING
ALL THE MOST IMPORTANT FACTS AND PRINCIPLES IN THE WORKS OF
FOURCROY AND CHAPTAL:
WITH
THE ADDITION
OF THE
MORE RECENT CHEMICAL DISCOVERIES WHICH HAVE BEEN MADE KNOWN IN BRITAIN AND ON THE CONTINENT;
AND
With a variety of Facts and Views,
WHICH HAVE NEVER BEFORE BEEN COMMUNICATED TO THE WORLD.

Intended for the Uſe, not only of thoſe who ſtudy Chemiſtry, with thoſe profeſſional Purpoſes to which this Study is commonly referred,—but alſo, for
FARMERS, MANUFACTURERS, DYERS,
AND THE
OTHER ARTISANS
OF
The Chemical Arts, in general, &c.

WITHDRAWN

BY ROBERT HERON.

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ERRATA.

Page 27. Line 17. for *not at all liable to evaporation*—read—*not liable to haſty evaporation.*

Page 27. Line ult. for *whatever neceſſarily*—read—*whatever air neceſſarily.*

Page 48. Line 4. for *an* read *the.*

Page 75. Line 21. for *fluid* read *volatile.*

DIRECTIONS TO THE BINDER.

THE Binder will pleaſe to obſerve, that the firſt Cancel is two Pages, folios 33 and 34.

The Second is SECTION II. BOOK II. from Page 61 to 65.

PREFACE.

Syſtems of Chemistry have been exceedingly multiplied within theſe laſt fifteen years. Thoſe of Fourcroy, Chaptal, and ſeveral other chemical authors, are ſo diſtinguiſhed for excellence, as to have been ſucceſsfully tranſlated into almoſt every modern European language. It ſeems ungenerous and unwiſe to drive an old teacher off the ſtage, merely to make room for a new one, who offers only novelty of perſon, without any important peculiarities, or tranſcendent advantages of inſtruction. It is, therefore, natural to expect, that every reader ſhould enquire,—*upon what peculiar* Improvements—in Science,—in the *detail of* Facts,—in Arrangement,—or in the *general* *mode of* DIDACTIC ENUNCIATION,—*does the Author of this new Compendium of the* ELEMENTS OF CHEMISTRY, *raiſe his claim to the Attention of the Public?*—To ſuch an enquiry, it is the object of this PREFACE, to give a direct, a preciſe, and, if poſſible, a ſatisfactory anſwer.

I. In every late work on the ELEMENTS OF CHEMISTRY, the doctrine—of—a PHLOGISTON, the principle of fire and of all the moſt active qualities of material bodies,—is aſſociated with the newer chemical truths, relative to *Combuſtion by the decompoſition of Gas-Oxygen, &c.*—with a confuſion and an uncertainty,—which inexpreſſibly perplex the mind of the ſtudent, make it almoſt impoſſible for him to comprehend the principles of Chemiſtry, and even ſpread an air of falſehood and uncertainty over the details of its facts. Chemiſts in general had been ſo accuſtomed to ſpeak, to think, to write, in the language of that which is called the PHLOGISTIC THEORY, and to conduct their experiments upon its views; that, even after relinquiſhing *it*, as falſe, few of them have been able ſufficiently to accommodate their thoughts and language to the truths of the NEW SYSTEM. Even the works of the beſt French Chemiſts, ſuch as FOURCROY and CHAPTAL, ſhew not a little of this confuſion. It triumphs in the chemical writings of moſt of thoſe great men, the

STOLIDISSIMI of Germany. Some perſons have, of deſign, and *with a view to pleaſe all parties,* made the vain attempt to produce uſeful compendia of the Elements of Chemiſtry, in which the ſecret relations of every ſeries of phœnomena ſhould be explained both upon the principles of the *Old Theory*, and upon thoſe of the *New*. But, in all theſe inſtances, this confuſion of Theories of which I complain, however it may have been produced, —though perhaps leſs embarraſſing to experienced chemiſts,—has infinitely enhanced the difficulties of the ſcience, to every beginning learner. In no department of ſcientific inſtruction, is it poſſible for the mind, at firſt, to find its way amid the doublings and contrarieties of two incompatible theories. You muſt, in the firſt inſtance, give one conſiſtent ſet of principles to the ſtudent whom you wiſh to ſtudy any ſcience with eagerneſs and ſucceſs. After his intellect has, once, had a clear view of the whole range of the ſcience; then, but not till then, call him to compare oppoſite theories, and decide between diſagreeing ſyſtems.

This was one of the firſt conſiderations which prompted the writer of the following work, to engage in its compoſition. He has, every where, explained the relations of all the phœnomena, agreeably to thoſe principles of modern diſcovery of which LAVOISIER is reſpected as the author.

his book, in every inſtance, ſpeaks the language, and breathes the air, of the New Doctrine. That doctrine, is, now, unqueſtionably, DEMONSTRATED TRUTH. But, were *it* even otherwiſe; he cannot but hope, that the ſtudent muſt derive much more inſtruction from the peruſal of a work which unfolds only one conſiſtent ſeries of principles, than [illegible] diſplayed an illogical medley of ſuppoſitions contending one againſt another, like the elements of Nature in the Chaos of the Poets.—He has not, however, entirely overlooked the *Theory of Phlogiſton*, but has thrown a ſhort account of it into an Appendix,—which he could wiſh, not to be peruſed, till after the preceding part of the book ſhall have been read.

II. In all former ſyſtems of Chemiſtry,—except only that admirable treatiſe, the *Philoſophy of Chemiſtry*, by FOURCROY,—there prevails—*an unſcientific [illegible] of arrangement*, exhibiting the different chemical ſubſtances, not ſo much in the order of ſyſtem, as if they were taken up, one after another, out of a heap careleſsly thrown on the floor of the Laboratory, or from the ſhelves in an Apothecary's ſhop. Such a work neceſſarily propoſes to teach ſcience in a ſort of Synthetic order. But there is, in truth, neither Syntheſis nor Analyſis nor any order whatſoever, in the manner in which the hiſtories of the different chemical ſubſtances are made

made to follow one another in almoſt all our books of Chemiſtry. This confuſion ſeems to proceed from mingling the arrangement of the old theories with ſomewhat of that which would be obſerved in Natural Hiſtory, and with an accommodation of the whole to the conveniencies of exhibition and experiment. It degrades ſcience into the diſorder of the moſt inelegant arts. It hinders the ſtudent from expanding his mind, as he advances, to the enlarged abſtraction of genuine ſcience. It has the effect of admitting as little as poſſible of reaſoning, into a branch of knowledge that, in its preſent ſtate, may be uſed to form the mind to cloſe and accurate ratiocination, perhaps more ſucceſsfully than any one elſe.

In the following work, a more ſcientific and logical arrangement has been attempted. The *ſimple ſubſtances*,—at leaſt thoſe which have not been hitherto decompoſed, are conſidered ſo many diſtinct Classes: *Compounds* in which, two or three of theſe ſimple ſubſtances, exiſt in union, are regarded as Orders: the *Compounds* of thoſe compounds, conſtitute Genera: ſubordinate to theſe are the Species; which are, of courſe, made up of Varieties; and theſe, of Individuals.

In giving the chemical hiſtory of this ſyſtem of ſubſtances, the Author of the following work has, therefore, taken each Class by itſelf, and endeavoured to purſue its hiſtory, through all its ſubordinate parts, ſo low, at leaſt, as to its different ſpecies. To deſcend into the detail of the *Individuals* has been hitherto regarded, as the proper buſineſs, rather of NATURAL HISTORY, than of CHEMISTRY: and the limits within which the Author of this work was obliged to confine its extent, would not admit of his introducing into it, any detail ſo diffuſe, and ſo much multiplied*. Thoſe *ſimple ſubſtances* which are known to be the moſt extenſive in their combinations, or the moſt conſpicuous in their action, have been introduced, the firſt: and the progreſs of the work has been contrived, for as much as was poſſible, to proceed, regularly, from the more important and conſpicuous CLASSES, to thoſe which are the leaſt ſo. Not that he has dared, in every inſtance, rigorouſly to follow that plan of arrangement which he eſteemed the moſt conſiſtent with ſcientific preciſion. Something was to be ſacrificed to old prejudices, and to prevalent habits of thinking: A certain attention was due to what the convenience of the writer and the learner, ſeemed in particular inſtances to require. The *Compound baſes of Acids*,

are

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[*] For the Chemical and Phyſical hiſtory of the Individual ſubſtances belonging to this Science, I cannot do better than refer the reader to KIRWAN'S ELEMENTS OF MINERALOGY,—and Dr. BABINGTON'S NEW SYSTEM OF MINERALOGY, recently publiſhed.

are, on this account, introduced, in ſucceſſion, after the *ſimple ones*. The *bitumens*, and ſeveral other combuſtible ſubſtances, with thoſe which are called the *immediate principles* of *Animal* and *Vegetable Bodies* fill a ſeparate *Book*. And, in various inſtances, in the courſe of his arrangement, will be found a departure from that rigorous order which his judgment preferred as truly ſcientific, though not the moſt familiar.

On the whole, he cannot but hope, that the arrangement which he has followed, will be found to be not only the moſt ſcientific, but by much the beſt adapted to open up the ſcience of Chemiſtry, to the eaſy intelligence of the reader's mind.

III. The writers of the beſt ſyſtems of Chemiſtry which have been hitherto offered to the Public; anxious to detail every fact, and to deſcribe every proceſs, and every phœnomenon with the utmoſt minuteneſs of explication; have very often deſcended into a particularity in the ſtatement of circumſtances, by which, that which they ſought to make exceedingly plain, has been rendered ſo much the more obſcure. They enter into a deſcription of every movement of the hand in the laboratory, with a prolixity of phraſes, a confuſion and inaccuracy of language, an embarraſſment of ſentences, by which the mind of the ſtudent is utterly confounded and bewildered. Even when, with

their

their books in his hands, he witneſſes the appearances and experiments which they relate; it is often ſcarcely poſſible for him, to trace the agreement between the facts and the narrative of them. Until he become ſo expert a chemiſt, that the inſtruction of ſuch books, ſhall ceaſe to be uſeful; the books themſelves begin not to be eaſily underſtood.

In the following work, it has been endeavoured, perhaps, indeed, without ſucceſs, to relate chemical facts and experiments, in ſuch a mediate manner between obſcure brevity and indiſtinct prolixity,—that the book may be intelligible, even at a diſtance from the Laboratory, to the young chemiſt,—that, if he witneſs accurately performed experiments, with it in his hand, he ſhall eaſily be able to compare the fact with the deſcription of it, —and that, if he chuſe to attempt experiments by himſelf, without any other guide, than this work, —it may afford him directions much more ſerviceable, than thoſe of a perplexed and blundering prolixity. It has been, here, endeavoured to ſelect and faithfully to relate all the leading and eſſential appearances in the progreſs of every experiment; while, to avoid tedioufneſs of detail, —*every indifferent circumſtance*, has been, for as much as was poſſible, paſſed over without notice.

IV. It

IV. It has been hitherto, uſual for the authors of ſyſtems of the Elements of Chemical Science, to introduce,—as I think, unſeaſonably,—throughout their books,—details of the practice of ſeveral of the chemical arts, at a time when the ſtudent cannot be ſuppoſed to poſſeſs all the chemical knowledge which is requiſite to the due intelligence of a practice in which there is often a combination of all that is moſt difficult, complicated, and refined in the ſcience and the manipulations of Chemiſtry.—This contributes more than any thing elſe, to render the ſtudy of Chemiſtry, inexpreſſibly difficult. The ſtudent flounders on from one chaos to another. It is, as if, amid the leſſons for a child who is as yet but learning to read ſingle, ſolitary ſyllables, you ſhould here and there interpoſe cluſters of words of five, ſix, and ſeven ſyllables, with many ſilent letters. The ſtudent may toil on: but, whether in a book, or in an exhibition of experiments; all is to his mind, perplexity and confuſion. He may thus learn the language of Chemiſtry; he may even comprehend the ratio of this or that manipulation or phœnomenon:—But, he does not conceive of the whole, as a Science; he cannot rightly underſtand the union and regular ſubordination of the parts: Nothing but the labour of a whole life, and the advantage of other means of receiving inſtruction, can bring him at laſt, to underſtand the entire Syſtem: And even ſtill, he will be apt to conceive of the different chemical arts, rather as ſo many ſeparate myſteries, than as depending, in all their operations, on the firſt principles of chemical Science. To moſt, even of thoſe who pretend to be the fondeſt of Chemiſtry,—the exhibitions at chemical Lectures, are much like the ſleight-of-hand tricks of jugglers, or thoſe ſucceſſions of paintings, which are, under various names, exhibited, as theatrical entertainments. The attendants at thoſe Lectures, go to ſee tricks, to wonder at appearances, of which the cauſes and relations are not, with due preciſion and ſimplicity, unfolded to them. It muſt continue to be ſo, as long, as in either Books or Lectures, the different ſubjects of chemical inveſtigation, ſhall be preſented, otherwiſe, than in a due progreſſion from that which is *ſimple*, to that which is the *moſt complex*. Chemiſts, in writing ſyſtems of their Science, appear to have, generally forgotten; that they wrote for perſons who were to be gradually inſtructed in that Science. By conſequence, they have not accommodated their mode of inſtruction to the natural opening of the human mind.

On the contrary, in the following work, very great care has been uſed, to ſtate the facts with as much ſimplicity and conciſeneſs as poſſible, in opening

opening up the ſyſtem of the general truths of the ſcience. The application of chemical Science to explain the moſt complex appearances of Nature, and the moſt difficult proceſſes of the Chemical Arts, has been poſtponed, till the general Elements of the Science have been, firſt, diſtinctly unfolded. Whenever, in the former part of the book, references to the proceſſes of the more complicated, practical arts, were unavoidably to be made; the utmoſt brevity that was not incompatible with perſpicuity, has been uſed in ſpeaking of them. The details of *Mineralogy*, the chemical phœnomena which lead to a true theory of *Geology*, the chemical relations of *Vegetation*, the hitherto neglected chemiſtry of the functions of *Animal Life*, have been introduced only in the *Laſt Book* of this Work,—and not before all the ſimpler parts of which the knowledge was neceſſary to the intelligence of theſe, had been previouſly explained. In the explanation of the Chemical Arts, the ſame œconomy has been obſerved. The chemiſtry of *Agriculture*, *Bleaching*, *Dyeing*, the making of *Glaſs*, the preparation of *Tobacco*, the manufacture of *Soap*, &c.—has been, in like manner, introduced only in the ſame laſt book, where it ſeemed that the ſtudent might the moſt eaſily underſtand it. After every endeavour had been uſed to familiarize the mind of the ſtudent, with all the ſimpler combinations and decompoſitions of Chemiſtry;

miſtry; then, but not till then, might he, as was conceived, eaſily underſtand and judge of, theſe more complex details. CHAPTAL diffuſes his ſyſtem, too much, into accounts, unſeaſonably introduced, of the proceſſes of Art. Even the more philoſophical FOURCROY, though he ſhew more of ſyſtematic propriety of arrangement, yet, amidſt his elaborate copiouſneſs, often introduces details of complex proceſſes, in parts in the progreſs of his ſyſtem, where the mind of the reader has not been prepared by what goes before, to comprehend them.

As many as poſſible of thoſe lengthened details of Natural Hiſtory, which other Chemiſts ſcatter through their ſyſtems,—have been rejected from this one. They may be valuable; but, they tend too much to diſtract the mind, and to withdraw it from ſufficient keenneſs of attention to the capital object. Of theſe details, there is greatly too much in the volumes of FOURCROY. So much as ſeemed indiſpenſibly requiſite, has been here preſerved; but digreſſions into the regions of Natural Hiſtory have been ſtudiouſly avoided.

V. As chemiſts, we, in Britain, have been long, the humble diſciples of the French and Germans. Our Syſtems and Manuals of this Science being chiefly tranſlations of the books of foreigners, do not exhibit in their illuſtrations, the Britiſh,

so

ſo much as the French and the German practice of the chemical Arts. It is, certainly, very deſirable, to know the foreign practice of theſe Arts, eſpecially where that foreign practice is, in any reſpect, better than our own. But, in learning the elements of chemical Science, if the ſtudent wiſh to make this knowledge directly uſeful to him, in his own country; it is undeniably better for him to learn, firſt, the uſe of thoſe Elements in Engliſh Arts. Reading the tranſlated books of foreign Chemiſts,—and the Engliſh compilations from them,—one would almoſt ſuppoſe Britain to be entirely without mines, iron-works, ſoaperies, dyers, potteries, glaſs-works, and even every other chemical manufacture. In the periodical miſcellanies, we are treated much in the ſame manner. It is ſo much eaſier to fill theſe with tranſlations from books and pamphlets in foreign languages, than to procure original information of real importance, to occupy their pages, that our magazines, &c. of almoſt all ſorts, ſpeak as if Britain were a country deſtitute alike of all art and all ſcience, ſave what it derives from the ſuperior induſtry and illumination of the French and Germans. Moſt eminently does this take place, in regard to the chemical Arts. Ever ſince Chemiſtry was ſo much illuſtrated by the diſcoveries of Lavoiſier,—it has been fancied, that the French alone were entitled to dictate in chemical ſcience to all Europe. After reading almoſt all our common books of chemiſtry, and trying moſt of the experiments which they ſuggeſt,—one ſhall be quite a novice in the Engliſh practice of all the chemical Arts.

In the compoſition of the following chemical work, therefore, the Author was willing to introduce as much as poſſible, of the Engliſh practice of thoſe arts which depend upon chemical principles. He has not, however, been able to do this, ſo completely as he wiſhed. It became indiſpenſibly neceſſary to him, to introduce the ſcience and the facts of FOURCROY and CHAPTAL. He did not poſſeſs advantages ſufficient to enable him to procure all the neceſſary information concerning the practice of ſuch arts in England. The plan of his Book,—as to extent,—did not permit him to introduce the whole of even that little knowledge of ſuch things, which he actually poſſeſſed.

Yet, in almoſt all theſe accounts of the practice of different chemical arts which are contained in the *laſt Book* of the following work, it is the Engliſh practice that is exhibited. The *ſpecifications* of *Patents* in that very valuable periodical work, the REPERTORY OF ARTS; the precious volumes of the TRANSACTIONS *of the* ROYAL SOCIETIES *of London and Edinburgh*; the Tranſactions

tions of the Society of Arts, the Philosophical Society of Manchester, the Highland Society of Scotland, the Agricultural Society of Bath, &c. furniſh much important matter, to fill up the hiſtory of the chemical arts in Britain. We have, alſo, many ſeparate publications of great merit, upon the Britiſh practice of different branches of the chemical Arts. From all theſe ſources, as well as from his own experience and obſervation, the Author of the following work, has derived uſeful materials for its *laſt Book*. But, he has been neceſſarily much more brief, upon theſe ſubjects, than he could have wiſhed. He has explained little more than the *ratio* of a few of the chemical Arts. If he ſhall be acknowledged to have, here, ſet an example which may be uſefully imitated at much greater length, by others,—this is the higheſt praiſe which he would, here, claim. He was, indeed, afraid of expatiating too much in a *novelty*, which the petulant and injudicious may, even in its preſent ſtate, ſufficiently forward to blame.

VI. The following System exhibits alſo, not a few *novelties of Science.*

1. The *operations and the relations of* Caloric, will be found to be explained in it, with an attention to all the tranſitions of that ſubſtance, and to ferent modes of combination and exiſtence, which

which has not been diſplayed in any former mical Syſtem. Much inaccuracy and con ſtill enter into all our chemical reaſonings at periments in conſequence of our inattention precife action of Caloric. It is hoped, th preciſion with which it is attempted to trac eſtimate that action, particularly in the latte of the following work, may tend to prom no ſmall degree, the improvement of che obſervation, experiment and reaſoning, in all various parts.

2. Of Light or *Lumen*, too, this work bits in its account of the art of dying, a ne peculiar idea; repreſenting Light merely a medium of colour,—not properly an aſſembl all the different colours; and referring *colo* tire to the minute ſtructure chemical and me cal, of bodies at their viſible ſurfaces. Thi at firſt ſight, ſeem but an unſupported op Yet, when all the chemical facts concerni variations, and the communication of colours have been duely conſidered;—philoſophers certainly, find it utterly impoſſible to refute new doctrine concerning Light, which has here, for the firſt time, deciſively advanced.

3. In regard to many phœnomena to whi general doctrines of ſcientific chemiſtry ha been, before, carefully applied,—attempts

theſe, throughout this work, made, to ex-
ll the ſecret relations of their different ap-
pea, in a manner ſufficiently compatible with
nciples of that which is called the PNEU-
l CHEMISTRY. The attempts always ex-
he exact reſults of an induction of *Facts* and
ples; and therefore afford, whenever they
new principles of combination by which the
are made more eaſily intelligible, and are
le to afford inferences—of uſe to direct the
ce of the Arts.

It is neither a hopeleſs nor an uſeleſs taſk, to
our, *to trace the changes which have taken
on the matter of this Earth, ſince, it was,
ſubjected to the operation of thoſe Laws, by
all its phænomena are, at preſent, regulated.*
—to cultivate the ſcience of GEOLOGY, or to
what is called a THEORY OF THE EARTH.
ſince mankind began to think with any de-
comprehenſion, concerning the origin and
l ſtructure of the orb which they inhabit;
have, both learned and vulgar, formed
able *Theories of the Earth.* While its re-
to the reſt of the planetary ſyſtem were
, its whole ſurface not yet ſurveyed,
ſtrata unexplored; ſuch theories were ne-
ly, too imperfect to deſerve any particular
. The progreſs of Aſtronomy, of Naviga-

tion, of Geography, Chemiſtry, Mineralogy, and Natural Hiſtory, has, in modern times, added ſo much to our knowledge of the Earth, that we may conſider ourſelves, as having advanced much beyond the ancients, towards the formation of a true ſcience of GEOLOGY. BURNET's Theory of the Earth, was but a theological Romance.— *Buffon* intermingles, in its compoſition, much of ſublime fancy, with valuable facts and pleaſing philoſophical ſpeculation. *Whiteburſt*, *De Luc* *Saauſſre* have contributed a vaſt aſſemblage of facts, and many ingenious, ſcientific ſuggeſtions. But, of all our bolder Geologiſts, the late Dr. HUTTON, of *Edinburgh*, and the preſent excellent preſident of the ROYAL IRISH ACADEMY, have, in the conſtruction of Theories of the Earth, afforded the beſt ſatisfaction to the ſcientific world. Even the Theories, however, of theſe illuſtrious Philoſophers, are obviouſly imperfect, and very far from having attained, either in the one or the other inſtance, to the truth and ſtability of unqueſtionable ſcience. On this difficult ground, the Author of the following Work, has alſo dared to tread. He has, *in the laſt Book*, propoſed *a View of the Origin and more remarkable Revolutions of this Earth*, which he believes to be ſupported by a more general and uniform conſent of *Facts* and *Analogies* than depoſe in favour of either the Theo of HUTTON, or that of KIRWAN. He gives it, not as abſolutely the ultimate truth of Science concerning the *origin* and *revolutions* of this terreſtrial globe, but as the moſt ſcientific account of theſe, which, in the preſent ſtate of our chemical and mineralogical knowledge can well be given. He has produced it, that if not itſelf unqueſtionable ſcience, it might, however, promote reſearch and diſcuſſion in a department of ſcience ſo truly important.

5. Chemiſtry has, never before, been applied with due care and accuracy, *to direct the labours of Agriculture, and to explain the phænomena of Vegetation.* In the following work, and in its laſt book, will be found an attempt to explain the germination, the growth, the florification, the ripening, the decay of plants, upon chemical principles, and by an induction of facts, which will probably appear ſound and juſt to all thoſe minds which are not withheld by unreaſonable prepoſſeſſions, from embracing the truth when it is preſented to them. The ordinary functions of vegetable life, are, alſo, placed in a new light, by the application of the principles of Chemiſtry. The Author will not affirm, that he has been, every where, completely ſucceſsful in what he has, on this head attempted. In truth, the *Phyſiology of Vegetables* has not, hitherto, been ſufficiently explained, to enable us to trace all the

chemical phœnomena of the organic functions of vegetables. That what is here ſtated, may explain ſome part of thoſe functions, more ſatisfactorily than they have been before explained,—and may introduce into this department of philoſophy, a new ſpirit of inveſtigation,—is the utmoſt that the Author preſumes to hope. There is no province of philoſophy, of which the cultivation would contribute more to the improvement of the moſt beneficial of the Arts of Life.

5. The MEDICAL ART,—on account of the complexity of the ſtructure and functions of the Animal Body,—as well as on account of the numberleſs relations of this body and its functions to all the parts of the ſurrounding ſyſtem of things,—remains ſtill in an exceedingly imperfect ſtate. We have attained, as yet, to but very—very few principles of medical ſcience. Though cultivated from the earlieſt times, MEDICINE was, long, much more an imp of Superſtition, than a child of Reaſon. In the days of HIPPOCRATES, indeed, conſiderable progreſs had been made in the collection of a body of facts, towards the conſtruction of a ſyſtem of medical rules. From his time, however, till *Anatomy* began to enlarge its reſearches and diſcoveries, in the hands of GALEN, Medicine continued to be practiſed without improvement. It was, during the dark ages of

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hiſtory of modern Europe, the impoſture of prieſts, the folly of old women, the quackery of vain empirics. Science and learning could not, immediately after their revival, do much towards the improvement of an art ſo complex, ſo refined, ſo awfully intereſting to all the hopes and fears of human life. PARACELSUS and the alchemiſts added the noſtrums of chemiſtry to thoſe which pharmacy had, before, derived from vegetable nature. The diſcoveries of the anatomiſts, and the progreſs of the mechanical philoſophy, taught the profeſſors of medicine to attribute almoſt all the phœnomena of health and ſickneſs to the ſtate of the *mechaniſm* of the animal frame. Amid the continued attentions which were paid to the phyſiology of the animal body, and in the progreſs of metaphyſical and moral philoſophy,—it became faſhionable to conſider vitality—in the varying forms of the *Vis Naturæ*,—as the only grand principle on which animal health could depend.

The Theories of *Hoffman*, *Cullen*, *Brown*, and their diſciples, are ſo many ſyſtems, widely removed from the truth of genuine ſcience, which repreſent *vitality*,—as acting with a ſort of myſterious operation in all the phœnomena of health and ſickneſs,—and as influenced, in its action, by external cauſes, in a manner, in which the laws of gravitation and chemical attraction, have little or

no

no part. In the later application of pneumatic chemiſtry to *medicine*, and of the gaſes as *remedies*, by Dr. BEDDOES and others,—it is, perhaps, not too much, to ſay, that there is much more of mere empiriciſm and of the ſuggeſtion or preſcription of chemical ſpecifics, than of any eſtabliſhment of principles upon the knowledge of that part which the laws and relations of Chemiſtry, perform in all the functions of Animal Life. In this ſtate of medical Science, or rather Theory, the Author of the following work has endeavoured to DEMONSTRATE, that, *in all the functions of the Animal Powers*, whether in health or ſickneſs, there intervenes, between the agency of *mechaniſm* and *mechanical cauſes*—and that of *vitality*,—a CHEMICAL AGENCY, the thorough knowledge of which, can, alone, enable us to eſtabliſh the foundations of true medical ſcience. This doctrine is entirely new in medicine. If true; it is of infinite importance. Of all the applications of Chemiſtry, it muſt prove the moſt beautiful and the moſt intereſting. It cannot but confer new dignity on chemical ſcience; ſince it exhibits it in this new relation to the principal utilities of human life. That the *general truth is fully demonſtrated*, the Author entertains the ſtrongeſt confidence: That he may have erred in ſome of thoſe particular details into which he has attempted to follow it,—is exceedingly

exceedingly probable. He cannot but hope, that, by the truly candid and philoſophical phyſician, he will be owned to have opened up a new path for medical inveſtigation, which, in preference to almoſt all others, deſerves to be inſtantly and diligently explored.

5. In regard to LIME and the FIXED ALKALIS,—but, eſpecially in regard to LIME,—he has ventured to propoſe a doctrine, which, though bold and new, is certainly ſupported by many facts and analogies. He has not, indeed, poſſeſſed ſufficient advantages for making thoſe deciſive experiments, by which the truth or futility of this new doctrine muſt be finally aſcertained. He has, however, pointed out thoſe experiments with a plainneſs of indication, which may render it very eaſy for any chemiſt who poſſeſſes a laboratory and the other requiſite advantages, to perform them.—If the *identity of* LIME *with* OXYGEN ſhall be proved; it will produce a change in all chemical ſcience, little leſs important and admirable, than the greateſt of thoſe which have reſulted from the reſearches and diſcoveries of chemical philoſophers, in the courſe of theſe laſt thirty years. But, experiments are by *ninety-nine out of every hundred* Chemiſts, performed imperfectly, and obſerved with ſo little of true, ſcientific vigilance, that, it will give little ſurprize to the Author of this doctrine,—if the experiments which

he recommends, ſhould be often tried, without appearing to yield thoſe reſults which he earneſtly expects from them.

6. Since the diſcoveries of Lavoisier, were received, as genuine ſcientific diſcoveries; various attempts have been made to evince, that they wanted the merit of originality. Rey, Hales, Black, Prieſtley, Cavendiſh, and more lately Mayow an Engliſh chemiſt of the laſt century, have been affirmed to have been the true Authors of all that was *ſubſtantially* valuable in the diſcoveries for which Lavoisier had been praiſed. Such attempts, ſo far as they are *invidious*, deſerve the warm reprobation of every true friend to genius and ſcience; ſo far as they have been prompted by the ingenuous philoſophical curioſity of tracing the progreſs of human opinions, and the ſlow maturation of uſeful diſcovery,—they deſerve the higheſt praiſe. Under the influence of this laſt principle, the Author of the following Work has endeavoured, with ſome pains, to aſcertain how far Lavoisier had been anticipated, in his diſcoveries, by others? He has, in this reſearch, found,—in a book that, for the knowledge which it contains, for the eloquence which it breathes, and on account of that grand ſcientific effort to the honour of which it is conſecrated,—ought to be in every perſon's hands;—he has found—even in Spratt's History of the Royal Society, an account

ment of a *Theory of Combuſtion*, not merely like to that of *Lavoiſier*, but, preciſely, identically, indubitably the ſame; a theory ſupported, too, by the indication of a train of experiments not leſs ample, than that of the French Chemiſts. It is not *poſſible*, that this Theory and the experiments indicated for its ſupport, ſhould have been unknown to the French Academicians. It is aſtoniſhing, that its exiſtence and its coincidence with that of Lavoiſier, ſhould not have been ſooner popularly pointed out.

7. Of the admirers of the writings, the inventions, and the ſcientific ardour of *Count* RUMFORD, the Author of the following Work, is one of the moſt zealous, and the moſt reſpectful. But, *Count* RUMFORD himſelf has, evidently, no other deſire, than to aſcertain the truth of ſcience in reſpect to the ſubjects of his inveſtigation,—and to apply that truth as happily as poſſible to the practice of the Arts, and the uſes of Life. The Author of this Work, therefore, has not ſcrupled to controvert ſome of the doctrines of that Philoſopher, which, though generally received, ſeemed to be entirely erroneous. Theſe doctrines are—that which repreſents water, as a non-conductor of heat, with *that* which ſeems to repreſent Heat merely a modification of motion,—and *ſome* ſubordinate poſitions dependent on thoſe two lead-

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ing ones. Perhaps, that which is here ſtated, will be confeſſed to have ſhewn, that the conteſted doctrines cannot be true. The views and arguments ſuggeſted, will be found to poſſeſs their ſhare of novelty. It may at leaſt be hoped, that the attempt cannot give offence.

8. The phænomena of ELECTRICITY have been obſerved with conſiderable diligence. Yet, the compoſition and intimate nature of the *Electric Fluid* have been, as yet, but little ſtudied. Obſerving,—that, in the flaſhes of lightning and of the electric ſpark, there is certainly, *Light*,—that, in combuſtion by lightning, there is, certainly, an action of *Fire*,—and that none of the other phænomena of Electricity, are incompatible with the idea of its being a *compound of Light with Heat*, under a particular modification: the Author has, in the following work, repreſented Electricity as being probably of this compoſition; and he very anxiouſly wiſhes, that the attention of Chemical Philoſophers could be turned to a more accurate examination of this ſubject.

Theſe are the moſt remarkable particulars in which the following work claims the merit of originality of Science. Its Author has ever been of opinion,—that, nothing can be more fatal to genius than *plodding over mere compilations*,—that nothing can be a ſurer proof of dulneſs, than *be acquainted with many topics* of knowledge, without ever having the energies of your own mind kindled, while you contemplate them, to generous efforts of invention. He will readily confeſs, this, If there be not ſomewhat of a ſpirit of originality breathed throughout the whole of his Work,—it cannot be fit to put into the hands of the young Chemical Student.

VII. In teaching every branch of knowledge, it ought to be a primary object with us, to teach it ſo, as to improve and invigorate for all common purpoſes, the REASONING FACULTIES of the mind. But, thoſe ſtudies which deſcend very much into minute details, and dwell, as it were, among theſe, almoſt alone,—have been obſerved, rather to enfeeble, than to invigorate and enliven the Reaſoning Powers of thoſe who cultivate them. With NATURAL HISTORY, notwithſtanding the beautiful Order and Abſtractions of the Linnæan Arrangement, this is, eminently the caſe. Chemiſtry, too, while it deals chiefly in details, without ſyſtem, or in wild unſubſtantial theory, muſt be equally unfavourable to all habits of ſteady and cloſe ratiocination. While its proceſſes of Syntheſis or Analyſis, took little or no notice of inſipid *reſidues* or of *gazeous products*; it tended to confound all the diſcrimination, and inductions of Logic. In its modern ſtate of improve-

improvement; Chemiſtry has become more capable of being taught in ſuch a manner as to exemplify the beſt perfection of reaſoning; and to habituate the mind of him who ſtudies it, to the beſt uſe of his reaſoning faculties. Nothing eſcapes obſervation: Every thing is now eſtimated with the utmoſt preciſion which it is poſſile to uſe, while we have to do, not with *Relations*, as in *Metaphyſics* and *Mathematics*, but with *Exiſtences*. The *laws* of *Chemiſtry*, and its *language*, are leſs remote, than thoſe of *Mathematics*, from thoſe of the buſineſs of common life: And habits of reaſoning apt to prove uſeful in the world, are, therefore, to be acquired more eaſily from the former of theſe ſciences, than from the latter.—Theſe ideas have been conſtantly preſent to the mind of the Author during the compoſition of the following work. He has endeavoured conſtantly to combine facts cloſely with principles, to keep the mind of him who ſhall peruſe this Work, ever awake to the Analyſis, to the Induction, to the Synthetic ſubjection of particulars to generals, through which the train of the compoſition, naturally conducts.—He has endeavoured to avoid all thoſe lengthened ſeries of Abſtraction, thoſe refinements in Speculation, during which the mind is apt to be bewildered for want of that frequent reference to particulars

without

without which, it can never think with clear, energetic intelligence. On the other hand, he has ſtriven to avoid thoſe prolix details of uncombined facts, in the explication of which, the mind is not neceſſarily prompted to abſtraction and generalization. If he do not exceedingly miſtake, the learner who ſtudies Chemiſtry in books unfolding it in this manner, will find the true uſe of rational Logic, to be more perfectly acquired in this, than in almoſt any other ſtudy.

VIII. It is not at all—to belie the Syſtems of Chemiſtry, which have been, hitherto, ſubmitted to the World, in Engliſh,—to affirm,—that STYLE had very little of the regard of their Authors, in their compoſition. The ſame thing may be ſaid of almoſt all thoſe books which treat of the *Phyſical Sciences*. Now, in every ſpecies of compoſition, propriety and perſpicuity of STYLE, muſt ever be of the utmoſt importance. They make abſtruſe ſcience infinitely eaſier and more pleaſing: They give a charm, even to what is frivolous and empty. The *Phyſical Sciences*, properly underſtood and explained, are not more incapable, than the Moral Sciences, of this *propriety and perſpicuity of* Style in the explication of them, of which we, now ſpeak. In the progreſs of the Arts of Compoſition, ſome happy ſpecimens of this have been exhibited. Why ſhould not CHEMISTRY, as well as that which is called *Natural Philoſophy*, have no ſhare in thoſe advantages? It was the wiſh of the Author of the following Work, to give his book the advantages of conciſeneſs, perſpicuity, and propriety of STYLE. The reader who carefully peruſes it; if he ſhall eaſily underſtand the ſenſe, and ſhall find it to poſſeſs, in a reaſonable degree, that livelineſs and thoſe attractions, which language and ſtyle have to beſtow,—will be beſt able to decide concerning the Author's ſucceſs in regard to this object.

IX. A *laſt*, though perhaps not to every one, the *leaſt* conſideration, is, that, as elementary Books ought to be, this work has been contrived to contain the greateſt poſſible quantity of matter, in the ſmalleſt volume into which that matter could be eaſily condenſed. There exiſts not at preſent, in Engliſh, any other work upon Chemiſtry, in which the ſtudent may find ſo much information within ſo little reading, and at ſo ſmall an expence. This argument comes ſo directly home to men's pockets and hearts, that, to enlarge upon it, were needleſs.

On the whole, it is not meant to inſinuate, that the following Work has not many faults, which the intelligent reader may eaſily find out. It only appeared neceſſary to ſhew the *expreſs deſign* of the Author, and the grounds on which he would wiſh in this work, to eſtabliſh his claim to public attention. Inaccuracies in language, errors in facts, vanities of theory, deficiencies and redundancies, ſometimes, diſorder—and ſometimes pedantry—of arrangement, will, no doubt be eaſily diſcovered in the courſe of this work. Yet, if its judges were to be the only candid and judicious; perhaps, the Author would have little reaſon to dread extreme ſeverity in the ſentence.

London,
Jan. 14, 1800.

R. HERON.

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AINING THE GENERAL NATURE; THE BENEFI-
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SECTION FIRST.

ERAL NATURE OF THE SCIENCE OF CHEMISTRY.

BOOK I.
SECT. I.

1.
Definition of chemiſtry.

ISTRY may be defined, *That Science which inveſ-*
nd explains the laws of that attraction which takes
ween the minute component particles of natural bodies;
thoſe of the attraction of gravitation, which is
to act between ſuch bodies, only in the ratio of
ſpective maſſes.

2.
Probable relation between chemical and general attraction.

een chemical attraction and the attraction of gravi-
there perhaps ſubſiſts in nature, ſome ſecret con-
which has hitherto eluded the reſearches of philo-
It may one day be diſcovered, that both theſe
of attraction belong to the ſame great, ultimate law
re.

3.
Inaccurate definitions of chemiſtry.

niſtry has been defined by others;—“ A ſcience
h the object is, to diſcover the nature and proper-
all bodies by means of analyſis and ſyntheſis;”—

[illegible] the intimate mutual
[illegible] A ſcience which examin
[illegible] upon natural bodies
[illegible] none of all theſe defi
[illegible] powers of the ſcience
[illegible] ſion, or to limit its fu

[illegible] are the ſubjects of chemical re
[illegible] compoſing the terreſtrial maſs
[illegible] fluids which penetrate its cavit
[illegible] the ærial ſubſtances circumf
[illegible] from the centre; the fires which
[illegible] irradiates; all inanimate, unorg
[illegible] properly the ſubjects of the chemiſt's
[illegible] the *naturaliſt* who remarks the diverſ
[illegible] appearance, or of the *natural philoſoph*
[illegible] in what manner they are influenced by th
[illegible] attraction. Even when moulded by the
[illegible] nature, into the organic forms of vegetables
[illegible] with thoſe powers of growth and irritab
[illegible] vegetative life ſeems to conſiſt: ſtill matter p
[illegible] qualities which chemiſtry delights to ex
[illegible] to be ſubject to thoſe laws which it is *it*
[illegible] aſcertain. Organized into the forms, and i
[illegible] the breath, of animal life; matter, in its minut
[illegible] particles, ſtill remains ſubject to chemical
[illegible] While the ſap ſwells the buds, and expan
leaves, of the tree; while the blood circulates throu
veins of the animal: vitality may predominate over
cal attraction, and wield it to its uſes; but never d
it. When in the vegetable or animal, the principle
is extinguiſhed; the laws of this attraction then

rights, and quickly diſſolve the organization of the y. So mighty are the powers! ſo vaſt the province of miſtry! ſtill graſping matter, amid all its infinite chan- of form! comprehending all that is in the univerſe, the pure energies of intellect, alone!

In examining the laws of that attraction which takes ce between the minute component particles of theſe bo- , chemiſtry employs either ſimple OBSERVATION, or rative EXPERIMENT. It either obſerves the proceſſes ich are inceſſantly taking place in the great laboratory nature; or inſtitutes, of purpoſe for this or that diſco- ry, new proceſſes of its own. When I obſerve, how clouds are effuſed in rain, how the torrid heat of the withers the verdure of the fields, how water is con- aled to ice, how metallic ſubſtances often loſe their luſ- e, and are corroded away in the open atmoſphere; in all ſe inſtances, I then acquire chemical knowledge by ſim- le OBSERVATION. When, again, I kindle a fire, that I may ſee it act upon ſome combuſtible matter; when I immerſe a ſolid in a fluid, that I may diſcover whether the ſolid will be diſſolved, in conſequence of the immerſion; when I attempt to meaſure the heat of the atmoſphere by an inſtrument; in theſe and other ſuch caſes, I inveſtigate chemical truth by EXPERIMENT. Of the chemical knowledge acquired by *obſervation*, every man poſſeſſes more or leſs. By ſimple *obſervation* alone, even a very extenſive knowledge of the chemical qualities of bodies may be obtained.

5. *Obſervation* and *experiment* are the means for the inveſtigation of chemical ſcience.

But, mere, unaſſiſted *obſervation* is ever, ſo inaccurate, ſo ſubject to accident, and ſo little capable of accompliſhing any continuous and connected plan; that chemical reſearch almoſt always aſſumes the form of EXPERIMENT. The *laboratory* muſt be conſtructed; the *furnace* muſt be kindled up;

6. Direct *experiment* is the principal means for the advancement of chemiſtry.

up; the water-bath, the ſand-bath, the cinder-bath
muſt be interpoſed between the naked fire, and the
under examination; cupels, crucibles, aludels muſt be
ployed; the thermometer, the pyrometer, the hygro
muſt correct the callouſneſs and inaccuracy of ſenſa
the air muſt be meaſured out in bottles, and the w
muſt be weighed in a balance; in order to our ma
any uſeful progreſs in the ſyſtematical knowledge of
mical ſcience. Even where ſeries of *experiments* have
been regularly inſtituted, by ardent philoſophical enq
into this branch of knowledge; yet, ſtill, the greateſt ſto
of the moſt important chemical truths, have, even in ſ
ſituations, been derived from *experiment*. The arts of
miner, and of the metallurgiſt, furniſhed much experime
chemical knowledge, before chemiſtry had yet begun to
proſecuted as a ſcience. Many of the moſt important c
mical truths have been diſcovered, in conſequence of
periments inſtituted for the improvement of the ſcience
natural philoſophy, or in order to aſcertain ſome curi
fact in natural hiſtory. But, only ſince *experiments* have be
multiplied with views directly and preciſely chemical;
ſince even the ſimpleſt and moſt obvious *obſervations* h
been made with all the preciſion and care of artificial
periment; has chemiſtry begun to aſſume its proper
truly exalted rank among the phyſical ſciences.

and
s,—
in
l
ies.

The *experiments* of chemiſtry have been uſually re
ſented as either *analytical*, and thus reſolving bodies
complex character into their firſt elements; or *ſynthe*
and thus compounding ſimple ſubſtances into new co
nations. But, in truth, a perfect *ſyntheſis*, a pure and
analyſis, is ſcarcely ever accompliſhed by the proceſſ
hemiſtry. We cannot diſſolve exiſtent combinati

wi

t the ſame time effecting new ones: We cannot
ſimple ſubſtances into a new union, without de-
lmoſt always more or fewer of them, out of com-
in which they before ſubſiſted. When, for in-
y combuſtible body is diſſolved by fire; it is nei-
hilated, nor yet are its different conſtituent parts
into a permanently ſeparate ſtate. Its very aſhes
combination, containing ſomething that actually
the burnt body before its combuſtion, with ſome-
t has been, during the combuſtion, abſorbed from
mambient atmoſphere. Of its other parts, ſome
ered perhaps into new aeriform compounds; ſome
liquid compounds; and ſome, it may be, into new
ions in a fixed and ſolid form. Nature rarely
in a pure ſimple ſtate, any of thoſe ſubſtances
e recognized by chemiſtry, as elementary. Nor
arth, a ſalt, a metal be obtained pure and ſeparate,
e than by detaching into new combinations, thoſe
tters with which it was naturally contaminated or
Do I wiſh to analyſe any mineral water? Its parts
ſeparated from one another, by a long ſeries of
, eliciting them ſtill, one after another, out of their
bination, by preſenting new ſubſtances with which
y be more ſtrongly diſpoſed to combine. Do I
compound a ſoap for the uſe of the bleacher, a
cookery, a medicine that may diſpel diſeaſe? Ma-
l analyſes are ſtill to be incidentally performed,
am endeavouring to accompliſh ſuch ſynthetical
. It is thus that *ſyntheſis* and *analyſis* are conſtant-
ted together, as well in all the experiments of che-
s in all the reaſonings of the human underſtand-
very few and ſimple inſtances, analyſis may

be

be accompliſhed without a concomitant ſyntheſis without a concomitant analyſis. But, even in extenſive chemical experience, ſuch inſtances ar fully rare.

8. The nature of the facts aſcertained by chemiſtry.

Employing thus its reſearches upon all materi ces; not ſlighting opportunities for ſimple *obſer* truſting much more to the accuracy and the c views of *experiment*; mingling analyſis with ſynt tinually compoſing and decompoſing: Chemiſtry diſcovers the mutual *affinities* of all the bodies What ſolid ſalt will the ſooneſt diſſolve in wat metal will be the moſt rapidly melted and calcine What does water give out or receive, when it is ed into ice or into vapour? By what means ſh that colour be permanently fixed in that piece o be effaced from it? How ſhall I extract a rich li theſe fruits? How ſhall I impregnate water with of theſe herbs? Of this nature are the problems ſcience of chemiſtry ſolves, concerning the ſubſt which its reſearches are exerciſed.

SECTION SECOND.

THE BENEFICIAL USES OF THE SCIENCE OF CHEMISTRY.

BOOK I.
SECT. II.

CHEMISTRY is not adapted merely for the amuſement of the recluſe philoſopher. It extends itſelf into the provinces of active life. It is the nurſing-mother and guide of almoſt all the more uſeful and important arts. It holds out a light to irradiate almoſt all the other phyſical ſciences. If the arts of common life be divided into the two claſſes of the *chemical* and the *mechanical;* the former will be found to be greatly the moſt numerous, and not at all the leaſt important.

1. Chemiſtry enters into almoſt all the other ſciences and arts.

Even that **COMMON SENSE** which every man is expected to poſſeſs, in a greater or a ſmaller degree, comprehends, agreeably to the ordinarily received idea of it, no ſmall ſhare of chemical knowledge. The ſolvent power of liquids; the ſolubility of ſugar and common ſalt, with the inſolubility of wood, ſtones, and metals; the more obvious relations between rain, ſnow, froſt, and ice; the more obvious action of fire upon ſuch other bodies as are familiarly expoſed to its agency; the qualities of ſome of the moſt common colouring and detergent matters; are, all, things of which to be ignorant, would be accounted, in any grown up perſon, a want of *common ſenſe;* and things, at the ſame time, which it is the proper buſineſs of chemical obſervation alone to teach.

2. Common ſenſe cannot be poſſeſſed, without ſome ſhare of chemical knowledge.

All thoſe arts which are employed in working up **FOSSIL BODIES** into new forms, depend more or leſs upon chemiſtry. How ſhould bricks, tiles, pipes, porcelain, be baked, and brought to a ſtate of hardneſs, in which they can be

3. The arts which have foſſil bodies for their ſubjects, are neceſſarily chemical.

fit for the uſes of architecture, or of kitchen and table fu niture; if the perſons by whom they are manufactured, we ignorant of the chemical qualities of fire, water, and clay Chemiſtry alone it is, which teaches the art of making gla by the combination of an earth with a ſaline ſubſtan Metals cannot be extracted from their ores, purified, an wrought, without the aid of chemiſtry. Without it, ho ſhould lime and ſand, with the addition of water, b wrought into a cement fit for the purpoſes of architecture How ſhould the combuſtible foſſils be diſtinguiſhed, without the lights of chemiſtry, from the incombuſtible? Without its direction, fewel could not be dug out of our mora ſes, or from the deeper bowels of the earth.

4.
uch alſo
re thoſe
hich have
or their
ubjects,
nimal and
egetable
ubſtances.

In the ſame manner all thoſe arts are ſignally indebte to the ſcience of chemiſtry, whoſe buſineſs it is, to wor up for the uſes of human life, as well VEGETAB and ANIMAL, as FOSSIL ſubſtances. *Agriculture* is, i an eminent degree, a chemical art. The uſes and the diverſity of manures; the influences of heat and cold, o drought and moiſture, of rains, ſnows, and noxious winds the nature of ſoils; the ſtate of grains, whether freſh and hale, or decayed and ſickly; with a thouſand other particulars of which the ſkilful knowledge is indiſpenſibly neceſſary to the truly able and intelligent huſbandman; ar ſcarcely to be at all acquired without the aſſiſtance of chemical ſcience. In the *dairy*, milk cannot be preſerved ſweet and freſh, butter cannot be made, cheeſe cannot be prepared, without a ſkill, and without the uſe of proceſſes which are wholly chemical. The *gardener* employed mo curiouſly upon ſubjects nearly ſimilar to thoſe of the huſbandman, equally needs the chemiſt's direction. The nature eſpecially of *manures*, whether for the garden or th

field

field, has begun to be much better underſtood, ſince it has been illuſtrated by the chemical reſearches of Mr Kirwan, and of the Earl of Dundonald. The whole proceſſes of the *vintage*; the arts of the *brewer* and the *diſtiller*; the preparation of cyder, perry, gooſeberry-wine; the conſerving of fruits, the making of jellies; the arts of the ſugar-baker; and many others ſimilar to theſe; depend, all, upon chemical principles. All the arts and receipts of *cookery*, fall alſo, properly ſpeaking, within the province of the chemiſt. It is by a portion of chemical knowledge, we diſtinguiſh when animal food is to be dreſſed freſh; in what manner ſalt preſerves it from putrefaction; how bacon and hams are to be prepared; what different ſauces beſt ſuit different diſhes; how fruits, and flour, and milk, &c. are beſt to be mixed by the paſtry-cook; what ſort of metals or earths, diſhes may be made of, without communicating any diſagreeable taſte or noxious quality to the meats which are prepared in them. The art of *bleaching* is entirely chemical; as is very remarkably evinced by the happy abbreviation and improvement of its proceſſes, in conſequence of the lately adopted uſe of the oxigenated muriatic acid. Any perſon who ſhall peruſe the valuable works of Berthollet and of Bancroft, or ſhall inſpect the apparatus and the proceſſes of the dyer, will be at once convinced, that none but a good chemiſt can be a ſkilful artiſan in the art of *dying*. *Vinegar* is a product of chemical art. Such alſo is even *meal*. The dreſſing of *leather*, the manufacture of *hats*, the preparation of painters'-colours, and even the laying of them on, are alſo arts, in a conſiderable degree, chemical.

5. The medical ſciences

In MEDICINE, very great benefit has ever been derived from the ſervices of chemiſtry. *Pharmacy*, which prepares the

ith all their
ubſervient
ts are in-
ebted to
emiſtry.

the remedies preſcribed by medicine, cannot move a fin without the directions of the chemiſt. Chemiſtry alo can explain the nature of all the ſubjects of the phar ceutical art; what alterations theſe are liable to under what new combinations may be produced by min them together. A proper knowledge of chemiſtry, is n ceſſary to prevent the phyſician from aſcribing to chemi influence, either too much or too little in the œconomy the human body, whether in health or in diſeaſe. N thing but the want of this due knowledge of chemiſt could have led phyſicians,—at one time, to conſider the hu man body, as nothing elſe but a little laboratory,—at a ther, to repreſent it, as merely an aſſemblage of the pow and inſtruments of mechanics. Both the ſolids and t fluids of the animal body, are fit ſubjects for chemical ex amination. Chemiſtry is continually furniſhing new rem dies to overcome and expel diſeaſe. Of this we have a greeable proofs, in its furniſhing ſo many powerful cou terpoiſons, and in the valuable medical uſes to which th æriform fluids begin to be ſucceſsfully applied. Chemi try has now analyſed all the different parts of the ani body, as well as a very great proportion of animal pr ducts in general: And it is hardly poſſible to relate ho much medicine has been enlightened by the reſults o theſe analyſes.

6.
Natural hiſ-
ory in all
ts branch-
s, is great-
y indebted
o chemiſ-
ry.

Among all the ſciences, there is none more remarkab indebted to chemiſtry, for the illuſtration which it yiel and the various benefits which its confers, than that v extenſive and important one, NATURAL HISTORY. merely inſpecting the exterior appearances of bodies, naturaliſt could rarely obtain all that knowledge of th which is requiſite for the purpoſes of his claſſificati

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Compare the ancient arrangements of mineralogy, with thoſe which have been framed, ſince chemical characters have been employed to aid the imperfections of thoſe which are merely phyſical! The former are ſcarcely intelligible, are confuſed, and of little uſe: The latter are readily underſtood, poſſeſs the beauty of order, and communicate a knowledge ſignally uſeful; whether we deſire to employ this or that foſſil in the uſes of life, or to proſecute inveſtigation to ſome general inferences concerning the ſtructure of this earth, and the nature and arrangement of its ſtrata. Are we to conſider the natural hiſtory of the waters, of the air, of vegetable nature? ſtill muſt chemiſtry furniſh more than half the facts, which it is the buſineſs of the naturaliſt to regiſter, concerning all theſe matters. As little can the *botaniſt* properly explain the origin of the ſap in trees, and the nature of the nutriment of plants, without knowing what chemiſtry teaches upon theſe ſubjects. How beautiful are thoſe chemical experiments of Ingenhouſze and ſome later inveſtigators, which ſhew the different effects of light and darkneſs upon the perſpiration and the atmoſphere of plants! Even in *zoology*, chemiſtry will be found to afford conſiderable aid, towards the inveſtigation of various facts, in the general œconomy of animals, in the examination of animal exuviæ, and eſpecially in reſearches concerning the diverſity of the food and exterior coverings of the different ſpecies, as well as concerning the diſeaſes to which they are reſpectively liable.

7. Even natural philoſophy is benefited by chemiſtry.

Nay, that grand branch of phyſics, which has been, by way of eminence, denominated *Natural Philoſophy;* however its votaries may exalt it, as ſuperior to chemiſtry, and altogether independent of it; is nevertheleſs often aſſiſted and enlightened by helps which the ſcience of chemiſtry can

can alone ſupply. Conſider the different provinces o hydroſtatics, pneumatics, electricity, optics, magnetiſm how often ſhall you find chemical facts and principles neceſſary to be introduced for the ſupport and illuſtration o the truths of natural philoſophy?

8. Chemical ſcience is uſeful for the improvement of all ſcientific reſearch in general.

Indeed, throughout all the wide range of ſcience; in almoſt all the ordinary practice of the uſeful arts of life that accuracy of inveſtigation which chemiſtry teaches and many of thoſe grand truths which it has diſcovered will be found of eſſential utility. Its intuition, its power ſeem to pervade the whole material world. Even poetry as has been admirably evinced in Dr Darwin's *Bota Garden*, neither rejects the materials which this ſcience offers, nor refuſes to adorn them with its faireſt embelliſhments.

9. Chemiſtry is benefited by all the other ſciences and arts.

Chemiſtry, it muſt be confeſſed, derives in its turn, infinite advantages from the other ſciences and arts. From the obſervations made in common life, from the manipulations of the arts, from the experiments and diſcoveries made in the proſecution of the other ſciences, has this great ſcience gradually taken its riſe. The various arts, and the ſeveral other branches of phyſical ſcience, are conſtantly contributing new diſcoveries of the higheſt value, to enlarge the vaſt body of chemical truths.

SECTION

SECTION THIRD.

HISTORY OF CHEMISTRY.

1.
Antediluvian chemiſtry.

ormal chemiſtry as a ſcience or an art, but the
dge of ſome of the moſt obvious chemical facts,
ve been coeval with the earlieſt exerciſe of the in-
and ſagacity of man upon the earth. Kindling
oulding clay, hammering metals, tempering mor-
e ANTEDILUVIANS, in theſe, and ſuch other ſimilar
s as they practiſed, neceſſarily acted with ſome
f chemical intelligence. *Tubal-Cain* is related to
en a worker in metals. *Noah* muſt have had not
hemical knowledge to enable him to preſerve the
e ſtores of proviſions in the ark, during the deluge.

2.
Chemiſtry of the Egyptians:

ſame Noah, when he preſſed wine from his grapes;
endents, when they prepared a particular cement
buildings on the plain of Shinar; the patriarchs
ey made cheeſe and butter from the milk of their
Syria; all exerciſed arts out of which chemical
was gradually to ariſe. In Egypt, the embalming
odies of the dead; perhaps thoſe myſterious arts
e magicians practiſed in emulation of the miracles
s; various preparations connected with the agri-
with the architecture, with the dying of the E-
s; and, it may be, ſome branches of knowledge,
e modes of art which have been loſt in the hiero-
of their prieſts; formed an aſſemblage of chemical
inciples, and rules, which muſt be owned to have
d ſomething like a body of rude ſcience. From
tian Hermes, chemiſtry was afterwards to receive
the

into the powe
ral cauſes, muſt be obliged to ſ
more of them in his ſkill and dex

3. The arts, and the phyſical phi
the which was till Socrates aroſe thei
eks: ſarily involved a conſiderable ſhare
Thales of Miletus regarded water
nature. Democritus of Abdera is
his life in the ſolitary ſtudy of pla
The work of Theophraſtus upon g
valuable remains of ancient ſcienc
phyſical reſearches of Ariſtotle, ap
chemical caſt. The preparation of
Greeks of the iſles, and of the Aſi
tinents; their uſe of detergent ea
whitening their ſullied garments;
painters, the cements uſed in their a
ſels baked of common clay; their
mens; their working of ſilver mines,
of the ore to malleability; were all,
which they cultivated in conſiderable
they cannot be ſaid to have as yet co
ed them into chemical ſcience

ercial nation of antiquity, who explored the wide ex-
of the Mediterranean ſea, and eſtabliſhed an inter-
of traffic between the Eaſt and the Weſt. They
vented the art of tinging garments with a purple co-
g matter, the blood of a ſpecies of ſhell-fiſh.x They
rought thoſe Britiſh tin-mines which ſupplied a me-
n thoſe days, peculiarly valuable, becauſe few metals
yet known, and becauſe but ſmall quantities of thoſe
ad been hitherto wrought up for the uſes of life.
was alſo of their invention. They, too, taught the
f conſerving the fruits of various plants, and of pre-
g balſams and uſeful extracts from others. Their co-
s, the Carthaginians, learned, and practiſed, and taught
eir arts. By the commerce of the Phœnicians and
aginians, thoſe arts were gradually diffuſed through-
he ancient world. The Greeks were, in very many
s, merely *their* diſciples.

5.
Of the Romans:

e ROMANS were not diſtinguiſhed among the nations
e ancient world, as diſcoverers in the arts, or inven-
n ſcience. But, when their conqueſts had ſubjugated
t all the civilized parts of the earth under their do-
n; other nations were then proud to practiſe all their
ingenious arts for Roman accommodation; and glad-
ght them to the ſons of Rome. In all the arts re-
e for the preparation, the preſervation, the cooling,
ixture of vinous, and even of other fermented liquors,
were more eminently ſkilled than the inhabitants of
and Italy in the days of *Pliny*. Almoſt all the me-
ere known to them in all their various degrees of
. *Columella* and the other writers on rural affairs,
ecorded their ſkill in the application of manures to
ve, by their chemical virtues, the fertility of the ſoils
which

x This they said to conceal the [illegible]
[illegible] process

father and ſon, of Holland; are diſtinguiſhed among th who, in the courſe of this period, proſecuted chemical ſearches in the hopes of diſcovering the art of mak gold. In this vain purſuit, their induſtry was unweari No diſappointment could extinguiſh their hopes: No plexed length of proceſſes could tire out their perſev ance. They were commonly reputed magicians amo their ignorant contemporaries: And they themſelves w ſometimes led to fancy or pretend, that what they ſoug was to be accompliſhed only by magic. Amidſt their al mical reſearches, they incidentally made not a few diſcoveries. Roger Bacon certainly invented the com tion of gunpowder: Lully wrote with ſome ſkill on preparation of aqua-fortis, and the properties of met Baſilius Valentinus was the author of many valuable, monial preparations: The Iſaacs appear from their writ to have been acquainted with aqua-regia and aqua-for Nay, theſe alchemiſts were even able to perſuade ſome their contemporaries, that they had actually ſucceed making gold: And a variety of incredible ſtories, ſuch only impoſture could propagate, only the ſimplicity of norance believe, have been commemorated concerning gold they made, and the money which was ſtruck ou it. The poſſibility of the diſcovery of an univerſal m cine which ſhould cure every diſeaſe, and give imm health and life to embodied man, was ſoon after conce by the imaginations of the medical alchemiſts. Para of Zurich confirmed this notion, and firſt gave it co quence. His rejection of the Galenical pharmacy for mical remedies; and the ſucceſs with which he empl mercury in the cure of the venereal diſeaſe and of others to which the ordinary remedies had been i

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BOOK I.
SECT. III.

for a time aſtoniſhed the world, and tranſported
magination almoſt to frenzy. The ſpirit of al-
as again revived, about the beginning of the ſeven-
ntury. The Roſicrucian fraternity, Sethon in
Vaughan in England, and others, perſuaded ſome
riends, and perhaps actually fancied, themſelves,
could make gold. Not a few men of rank, for-
wild avarice, were duped to waſte immenſe wealth
jects, by which alchemical impoſtors promiſed to
ll things for them, into gold. The famous Vil-
econd Duke of Buckingham of this name, waſted
ay thirty or forty thouſand pounds. Sir Kenelm
s another believer in the pretences of alchemy.
was ſo commonly a ſubject of fooliſh and popu-
ity in England, during the laſt century; that it
d to be a ſufficiently natural and happy ſubject of
pon the ſtage.

Riſe of philoſophical chemiſtry.

t theſe errours and impoſtures, however, the ap-
of chemiſtry to the ſervice of medicine, and to ex-
upon the metals, gradually began to give it the
diſtinct and peculiar branch of rational ſcience.
mery, Glauber ſtudied it as a ſcience fitted to diſ-
y new and uſeful qualities of natural bodies, but
dulging in regard to it, all thoſe extravagant fan-
had tranſported the minds of Paracelſus and the
. *James Barnet*, phyſician to the King of Po-
liſhed, about the middle of the ſeventeenth cen-
rk under the title of *Philoſophy of Chemiſtry*, in
miſtry was for the firſt time, formally honoured
denomination of *a peculiar* SCIENCE. *Joachim*
Spires, phyſician to the Electors of Mentz and
ailed in his noble work entitled *Phyſica Subterra-*

ious *STAHL*
upon the doctrines of *Beccher*,
of the great latent cauſe of alm
which was long to be received a
truth in this ſcience. He aſſert
flammable earth; which he der
and which, by its preſence, and b
of its various qualities, differently n
verſity of combinations and of cir
cording to him, all the moſt ſtriki
place upon bodies, the ſubjects of
Sulphur, and *on Salts*, with his *Trece*
ed him immortal honour. The illu
liever in the fundamental doctrine
compoſed a noble ſyſtematic work
miſtry; and diſtinguiſhed himſelf by
of chemical analyſis, to diſcover the
vegetables. The *Royal Philoſophical*
ed in the volumes of their *Tranſact*
facts. Meſſrs Rouelle,
of France; *Bergman* and

ngement, which were rapidly to exalt it to new honours ng the ſciences, and to conduct to general truths which uld explode the theory of phlogiſton. Chemiſtry, in e hands of theſe great men; was already exalted from beg merely the handmaid of medicine and of mineralogy; d was taught to expand her arms to embrace almoſt all e uſeful arts of life.

Many difficulties were found in the attempt to trace logiſton through all thoſe ſituations in which its preſence was ſaid to be neceſſary, in order to explain the chemical nomena ariſing. It was a ſubtle, airy principle, perptible only by its effects, not by its own immediate agency the powers of ſenſe. Thoſe qualities which were, in r inſtance, attributed to it, were incompatible with thoſe ther qualities which it was ſuppoſed to exhibit in *that* inance. But, there was nothing elſe that could be, with y ſhow of reaſon or probability, ſubſtituted inſtead of it: And the doctrine of *phlogiſton*, therefore, ſtill retained its honours. In the mean time, the views of phyſical ſcience were enlarged. The ſcience of electricity was, as it were, created, where there had been no ſuch thing as ſcience before. In *pneumatical* inveſtigation, philoſophers had been nſenſibly conducted, from examining the gravity, the elaſdicity, and other mechanical qualities of the atmoſphere, to ſerve with chemical accuracy, ſeveral different ſorts of r which were blended in it. The excellent *Stephen Hale* tained by chemical proceſſes, an ærial fluid from various dies; which, however, differed in ſmell, inflammability, and ſeveral other properties, from common atmoſpheric r. *Prieſtley* repeating the experiments of Hale, and inſtituting others which Hale had not attempted; was ſo fortunate as to diſcover *various* ærial fluids poſſeſſing pro-

OK I. T. III. perties which would, by no means, permit them to be confounded with the common air of the atmoſphere. From metallic calces he extracted an air of purity hitherto unknown. *Bayen*, a diſtinguiſhed French chemiſt, diſcovered that the *calces* of the metal called mercury, might be reduced from their unmalleable ſtate, to a ſtate in which they ſhould be running and malleable, without the application of the *phlogiſton* which had been hitherto thought neceſſary to this proceſs. He perceived, at the ſame time, that, during the *reduction*, they emitted an æriform fluid in great abundance. Dr Black diſcovered the exiſtence of *latent heat*; and extracted from mild magneſia and from chalk, a *gas*, by the loſs of which they were reduced to *cauſticity*. All these 9. tory of VOISIER. new reſearches, and the diſcoveries to which they led, were of a nature to puzzle and embarraſs the votaries of the doctrine of *phlogiſton*; contradicting many of its principal applications of the phœnomena which had been before obſerved; preſenting new phœnomena, to explain which, it could not poſſibly be applied; expoſing ſtill in ſtronger lights, the mutual inconſiſtency of thoſe different qualities which had been aſcribed to it. It was requiſite but to take one ſtep further; and *phlogiſton* might then be exploded. Lavoisier, a name ever to be illuſtrious in the annals of chemiſtry, inſtituted a ſeries of ſingularly ingenious and accurate experiments; the reſult of which was, to prove; that, in the phœnomena of combuſtion, in which above all others, it had been thought unqueſtionably certain, that an evolution of phlogiſton took place;—that in thoſe very phœnomena, the only events were the fixation and the diſengagement of airs, and of the *matter of heat* by him denominated *caloric*,—a ſubſtance altogether diſtinct from *phlogiſton*. His experiments, repeated under every diver-

ſity

circumſtances, by himſelf and by others; ſtill
l ſatisfactorily the ſame reſults. His reaſonings and
es were vigorouſly attacked by the diſciples of
But, his facts and principles triumphed; and his
ts became his diſciples. Expelled from its ſtrong-
combuſtion; inadmiſſible into many of the newly
d phœnomena; *phlogiſton* was now to be exploded
-entity: and other ſubſtances of recent diſcovery,
led to act the parts which had been before attri-
o it, in all the chemical phœnomena of nature.
y, Berthollet, Morveau-Guyton, Chaptal, warmly
l the Lavoiſierian doctrines. The chemical philo-
of Germany, Spain, Italy, and Britain, have gradu-
unced the theory of Stahl. The French Chemiſts,
e principles of Lavoiſier, made a new philoſophical
nent of chemical ſubſtances, and conſtructed a new
ature; in which from a few radical terms correſpond-
he ſimple ſubſtances, the names of all the com-
were, by the laws of ſtrict analogy, derived or
ded. Chemiſtry has, in conſequence of theſe e-
come univerſally throughout Europe, an object of
d faſhionable ſtudy. Numerous trains of new ex-
ts have been inſtituted; and their reſults have
confirm the doctrines of Lavoiſier in caſes in
e application of thoſe doctrines, had as yet de-
merely upon analogy. Several miſtakes have been
d. Some principles accounted ſimple, have been
into component parts. More chemical diſcoveries
the arts of life, have been made within the ſpace
twelve years, than had been made within thrice
e, before. Almoſt all the chemiſts in Europe,
w adopted the Lavoiſierian theory as demonſtrated

MENTS OF CHEMISTRY.

BOOK SECOND.

APPARATUS, AND THE TECHNICAL MANIPULATIONS OF CHEMISTRY.

1. Propriety of this early account of the apparatus, &c.

proceeding to explain the nature of thoſe ſub-
hich chemiſtry examines and deſcribes; it may
r to give a ſhort account of the inſtruments
eneral apparatus which chemiſtry employs, and
f the moſt remarkable of thoſe proceſſes to which
it neceſſary to have continual recourſe.

2. Obſervations and experiments cannot be made without the uſe of inſtruments.

ttle that can be with ſufficient accuracy *obſerved*
hyſical or chemical phœnomena of nature, without
f inſtruments to aſſiſt the imperfection of our
No *operations* can be performed, without the aid
, furnaces, meaſures, weights, and media of vari-
. All the *manipulations* of chemiſtry are redu-
a comparatively *ſmall number*, the previous know-
which, will greatly aid us in our endeavours to
nd theſe proceſſes, in their application to inveſtigate
re of every different material body.

3. Inſtruments for meaſuring the degrees of heat.

at, or rather *caloric*, as we ſhall immediately learn
it, is one of the greateſt agents in all the phœno-
nature, whether phyſical or chemical. Nothing
neceſſary in ſcientific obſervations and experiments,
remark carefully the degree in which this ſubſtance
t, and the manner in which it acts. For this pur-
en before chemiſtry had made any conſiderable
progreſs

OOK II.

4.

E THER-
MMETER.

progreſs in modern times, the THERMOMETER was inv ed, to meaſure the different degrees of the intenſity of h The *Thermometer* has been framed upon the conſiderat of the expanſibility of moſt ſubſtances under the action this great agent: or, if not merely of their expanſibili at leaſt of their being all liable to undergo certain differ changes, when certain different degrees of heat are appl to them. Thus, one degree of intenſe heat melts conc oils; another produces ebullition in water, or convert into vapour. Again, in the abſtraction of heat, one parti lar degree of cold produces the congelation of water; w there are other ſubſtances, to the congelation of which ſtill greater ſeverity of external cold is required. U that principle which is ſufficiently illuſtrated in theſe other ſimilar facts, was the idea of the conſtruction of thermometer firſt conceived. *Water*, *oil*, *ſpirit of win* alcohol, were the matters firſt adopted, to indicate the creaſe or diminution of heat. Incloſed in a tube of gl which might be applied to a bar of wood, having its face plain, ſmooth, and divided by croſs lines at e diſtances from one another; *ſpirit of wine* particu ly, was found to indicate, by the expanſion or contra of the ſame quantity of the fluid, the increaſe or diminu of its heat. The croſs lines, dividing the bar of wood i ſcale, indicated the preciſe degrees of the expanſion or traction, and by conſequence of the increaſe or diminuti the heat. In applying this inſtrument, thus framed, t particular body, for the purpoſe of meaſuring that particular heat, there was nothing more neceſſary th immerge the whole inſtrument, or at leaſt a particula of it into the ſubſtance under obſervation. On the indeed, were alſo to be marked, ſome of the moſt re ble degrees, at which the principal changes effected

in

diminution of the heat of bodies, were known
lace. Theſe things obſerved and performed,
ed the natural imperfection of the ſenſes, in af-
isfactory information concerning the laws of
to which heat was ſubject, and the changes
as capable to accompliſh.

5.
The thermometer with mercury.

r the metal known by the name of *mercury*, had
attract the attention of philoſophers upon its
expanſibility; *It* was found to be, of all known
the fitteſt to be uſed in the conſtruction of
ers. Liquids did not admit of a very extenſive
t is, the ſeries of degrees was not great, between
increaſe of heat, and the loweſt diminution of
was ſuſceptible of being diſtinctly indicated by
fluids. Mercury, on the other hand; being
was then ſuppoſed, at all ſuſceptible of congila-
g not at all liable to evaporation, and not eaſily
ated; could admit of a much wider range of de-
y thermometer, in the conſtruction of which it
yed. Mercury has therefore, for a long while,
t excluſively uſed in the conſtruction of this
l inſtrument. Long, hollow, and ſlender tubes
ed by the glaſsmakers. Theſe muſt be perfectly
; or, in other words, the cavity of the tube of
led for a thermometer, muſt be of the ſame
n all parts of its length. One end of this glaſs
n to be heated to ignition, and by a ſtream of
n from the other end, to be expanded while it
into a bulb. Immerſing the open end of the
quantity of clean dry mercury, and heating the
he flame of a candle; the operator muſt, next,
ns, expel from the tube, whatever air neceſſarily
entered

6.
Its conſtruction.

entered it, while it was open. As the air eſcapes, th mercury from the veſſel into which the open end of th tube is immerſed, will ariſe into the vacuum, and entirel fill the bulb. Let the application of a taper's flame t the bulb of the glaſs tube, be repeated, with a piece of paper wrapped carefully round its open end, till the laſt remains of air and moiſture, of which the preſence could poſſibly be ſuſpected, ſhall have been entirely expelled. The tube is now properly filled with mercury: what remains, is, to graduate it. In order to do this, immerſe it firſt into melting ſnow, or freezing water, the temperatur of which is known to be indicated by 32° in the ſcale of that which is denominated Fahrenheit's thermometer. Mark at what point in the height of the tube, the mercury ſtands, when it is in this ſtate of immerſion. Next apply the bulb to the hollow of your hand; and put it into your mouth; marking alſo to what point in your tube, the mercury is expanded, in conſequence of this application. If the bulb be duly proportioned to the length and widt of the tube, ſome drops of the mercury will run over, a the time when it is expoſed to the heat of the hand and th mouth. The diſtance between 32° and the top of the tub is thus compared with that between *freezing* and *blood-heat* namely 63°, the range between 32° and 95°. By the compariſon of theſe 63° with the whole range of the ſcale, whic it is deſired that the thermometer ſhould afford; the perſo conſtructing it, will be able to diſtinguiſh, whether the degrees are likely to be large or ſmall, and to proceed wit this tube and bulb, or to lay them aſide. He muſt nex ſettle with himſelf, at what point in the tube he wiſhes t have the freezing point; and he muſt make more or le of the mercury to boil over, according as he wiſhe the range of his thermometer ſhould be more or leſs extenſive. Still after each ebullition of this ſort, let the inſtrument be immerſed in freezing water, or ſnow, in order to ſhew, where will be the freezing point, with this particular quantity of mercury. When the range is thus duely divided and adjuſted; the mercury muſt be made again to boil, for the expulſion of any remaining air and moiſture. The flame of a candle, applied with the blow-pipe to the upper and open end of the tube, will then melt the glaſs, and thus cloſe it. The boiling point will be beſt aſcertained by immerſing your thermometer in ſteam, till the bulb touch the boiling water from which it iſſues. While this immerſion is performed; it will be proper either to uſe in boiling the water, a particular veſſel which has been recommended by the Royal Society of London; or elſe to cover the bulb of your tube with ſeveral folds of flannel or of linen; and to pour boiling water upon this cover, while the inſtrument is alſo ſurrounded by an atmoſphere of ſteam.

7. Thermometers of *Fahrenheit, Celſius, and Reaumur.*

Such is, in general, the proceſs for the conſtruction of a thermometer in which mercury is employed as the indicator. Three remarkable ſorts of thermometers are at preſent in very general uſe throughout Europe. Theſe are the thermometers of Fahrenheit, Reaumur, and Celſius. The differences diſtinguiſhing them from one another, conſiſt in the diviſion and numeration of the degrees on the ſcale, which is to be always formed upon the tube and the bar of wood, ivory, or whatever other material, to which the tube is applied. In the thermometer moſt generally uſed in Britain; that which was firſt conſtructed by Fahrenheit a Dutch artiſt; the freezing point is fixed at 32°—the boiling point, OOK II. point, at 212° above 0—or the part at which both the cending and deſcending ſeries of numbers commence. the thermometer which was firſt conſtructed by the mous Reaumur, and which is the moſt generally uſed France, the ſcale is divided into a ſmaller number of grees upon the ſame length, and numbers not more th 80° between the freezing and the boiling points. The fre ing point is fixed in this thermometer preciſely at 0°, term between the aſcending and the deſcending ſerie numbers. 100° is the number of the degrees between freezing and the boiling points in the ſcale of Celſius; the freezing point is in this as in the thermometer Reaumar fixed at 0°. One degree on the ſcale of Fahr heit, appears from this account to be equal to $\frac{4}{9}$ of a de on that of Reaumur, and to $\frac{5}{9}$ of a degree on that of Ce Upon the knowledge of this proportion, it is eaſy for ſtudent to reduce the degrees of any one of theſe th mometers, into degrees of any other of them.

8. s of the rmome-

One great advantage of the uſe of mercury in ther meters, conſiſts in its extraordinary and expanſive ſen lity. The varying heat of the atmoſphere; the he any apartment or elaboratory; the heat of any body w ever that can be conveniently applied to it; may be factorily aſcertained by means of this inſtrument. *range* has not neceſſarily any other limits than thoſe of *congelation* and the *oxydation* of mercury.

9. ROME-

But, this inſtrument, excellent as it is, has been unequal to the menſuration of the degrees of heat, that intenſity to which it is often raiſed in nature, muſt be frequently excited by art. To meaſure heats, therefore, to which the thermometer cannot plied, there have been other inſtruments invented

philoſophers. *Muſchenbroek*, a celebrated Dutch BOOK II.
pher, invented an inſtrument named a PYROMETER, 10.
h a bar of iron may be ſo applied, as to indicate by PYROME-
nſions under the influence of heat, all the different TER of *Muſchenbroek*:
of the intenſity of thoſe heats which are brought to
n it. Mr LEIDENFROST, more recently, obſerving, 11.
he hotter any metal is, ſo much the more ſlowly Of *Leidenfroſt*:
ops of water evaporate from its ſurface; has applied
owledge of this general fact, to the meaſurement of
gher degrees of heat. On *iron* heated to the degree
ebullition of water, he has obſerved, that a drop of
will evaporate in *one ſecond*. On melted *lead*, a drop
er will not be evaporated within leſs than *ſix* or *ſeven*
On red-hot iron, the ſpace of *thirty ſeconds* will be
ed to its evaporation. At the heat of 520°, Fahren-
he hot body will not accompliſh the evaporation of
p of water in leſs than *eighty-nine ſeconds*. This ſim-
eaſurement of heat by the application of drops of
to the ſurface of heated metallic bodies, may be at
very convenient in eſtimating the degrees of furnace
and it may probably be applied yet to heats conſi-
ly more intenſe than thoſe which are here mention-
Clay of perfect purity, inſtead of expanding like ſome
bodies, ſhrinks in the fire, in proportion to the de-
of heat applied to it. Upon the knowledge of this
the late ingenious Mr WEDGEWOOD, who acquired to 12.
nd ſo much celebrity by his manufacture of porcelain Of *Wedgewood*:
ther earthen wares; was led to conſtruct a PYROME-
f baked clay, for the meaſurement of intenſe furnace-
which has been adopted into very general uſe, and
en found to poſſeſs peculiar excellence. This in-
nt is alſo ſufficiently ſimple. It conſiſts of a gra-
duated

duated gauge, the rule of which is divided into 240 eq points, each $\frac{1}{10}$ of an inch; and with this gauge, of a cient number of pieces of the baked clay, which muſt ha been prepared in a red heat, and muſt be of given di ſions. Theſe pieces of clay, thus prepared, are firſt to applied cold, to the rule of the gauge, that there may miſtake take place in regard to their dimenſions. Th let any one of them be immerſed into the furnace-h which is to be meaſured. Leave it here, till it ſhall been completely penetrated by the heat. Then remo and apply it to the gauge. The difference between former and its preſent dimenſions, will ſhew, how much has ſhrunk; and will by conſequence indicate, to what gree, the intenſity of the heat to which it was expoſ might amount. Such is the *pyrometrical* contrivance WEDGEWOOD. A matter of ſuch high importance to th intereſts of chemiſtry, and of phyſical ſcience in gene has naturally engaged alſo the attention of other chemi philoſophers. Meſſrs LAVOISIER and DE LA PLACE, ious to find an accurate inſtrument for the meaſureme even the moſt intenſe furnace-heats, were ſo fortunate to invent a PYROMETER which may perhaps deſerve to preferred to all others. The *melting of ice* is the great upon which this pyrometer depends. The inſtru conſiſts of three circular veſſels, inſerted one within ther, and affording three ſeparate *capacities*, or receivi ſpaces. The *interior cavity*; formed by a grating of ir upon ſupports of the ſame metal, and cloſed by a cove above; is deſigned for the reception of the body under periment. The *middle cavity* contains the ice, the melti of which, is to meaſure the heat given out by the body the interior receptacle. The *exterior* or third *cavity* co tain

13.
f *Lavoiſier* nd *De la* *lace.*

e, intended to preclude any heat from the atmoſ-
from paſſing into the ice contained in the *ſecond ca-*
d thus injuring the accuracy of the experiment.
in the *ſecond cavity*, is to be melted ſolely by the
en out from the body in the interior or *firſt cavity*,
le of which it is deſtined to abſorb, while it diſ-
nto water. The water thus produced from the
ice in the *middle cavity*, is carefully preſerved. Af-
concluſion of the proceſs, it is of courſe weighed.
ht affords a meaſure of the heat given out from
ly under examination. It will be perceived, that
ument is accommodated to meaſure rather the de-
f the diminution, than thoſe of the augmentation
. However, it may be indirectly adapted alſo to
purpoſe.

The BAROMETER, though not properly a chemi-
ument; is, however, ſo neceſſary to give many
ions which are unavoidably requiſite to the accu-
f chemical obſervations; that its nature and ſtruc-
ſerve to be here explained. The preſſure of the
here and of all the exterior ſtrata of this globe, in-
the denſity of the interior ſtrata, always, more
, and renders the looſer parts of theſe latter ſtrata,
hat more fixed, than, *cæteris paribus*, they, other-
would be. Liquids and elaſtic fluids,—being ſub-
the laws of general gravitation,—and having
cohesion of parts, as might prevent one portion
from yielding to the impulſe of another,—tend,
they gravitate towards the Earth's centre, to re-
n conſtant equilibrum, one with another. When
ur any quantity of *water* into a vaſe; the water
itſelf equally in the veſſel, and ſettles at laſt, with
ſurface, above. The ſeas roll, becauſe their water
diſturbed

diſturbed by extrinſic cauſes tends continually, to recove general equality of level. The rivers run, for the ſame rea We can raiſe the water of any ſtream, even to a ſu elevation, as high as that of its ſource, ſolely on accoun this conſtant tendency in the parts of the fluid, to re *in equilibrio.* With *air,* it is the ſame. *Air* will not, l ſolid body, remain in that particular part alone, of a or veſſel, into which you put it. It diffuſes itſelf where equally. If by heat, you rarefy the air mo one place than in another; the unrarefied air tends to reſtore the equilibrium, by ruſhing in upon that was rarefied. Winds, and all commotions in the at phere, either depend ſolely upon this tendency to re in equilibrium, or at leaſt owe to it, a very conſide part of their phœnomena; ruffle the ſurface of the po we may refer from the common fluidity of them both. lilæo, Torricelli, and Merſenne, firſt, demonſtrated gravity of the atmoſphere; and ſhewed, that a colum water 32 feet high, is equal to counterbalance a col of air of the whole height of the atmoſphere. In wel of which the air has been exhauſted, water riſes to height. In the climates of Europe the weight of is to that of the air of the atmoſphere, as from 60 1000 is to 1. *Mercury,* though a metal, havin fluidity of water may be placed, alſo, in counterpoiſe air.—28 inches of a column of mercury,—juſt as w 32 feet of water,—will counterbalance a column o of the whole height of the atmoſphere. The BAROM is a tube incloſing mercury to riſe to the height inches,—leaving, above, a vacuum,—open at one en the acceſs of air. It was the invention of Boyle. mercury riſes and falls by laws not yet well underſto the gravity of the atmoſphere varies. In the general ſtruction of the Barometer—a quantity of mercury m

taken, which may be ſufficient, in the ordinary tempera-
e of the atmoſphere, to fill in a tube evacuated of air,
e few inches more than thoſe twenty-eight through which
natural that mercury riſe *in vacuo*. A ſyphon-tube of
, is then to be taken. Evacuate the tube of any air
ch may remain in it, by the proper application of exte-
heat. Put in mercury. Repeat the application of
. In the ordinary ſtate of the atmoſphere, twenty-
t inches of the mercury, will aſcend in a column, in
branch of the ſyphon which is exhauſted of air, and
e at its top. When the atmoſphere is unuſually heavy, its
aordinary weight preſſing upon the other branch of the
on which is not cloſe at the top, will force into the cloſe
exhauſted branch, more than twenty-eight inches of
ury. When, on the other hand, the atmoſphere is
ſually light; the mercury in the open branch of the
on will expand itſelf and aſcend; while the mercury
he cloſe and exhauſted branch, will deſcend beneath its
er and uſual height. Or, inſtead of thus uſing a bent
, it may be better, and the more common way has al-
been, to uſe a baſon or bulb of mercury open to the
ure of the atmoſphere. The only condition abſolute-
diſpenſable, is, that the baſon, or the bulb, or the ſe-
branch of the inflected tube be always open to the im-
on of the air. In order to enlarge the ſcale, and to
ve, as it were, the ſenſibility of this inſtrument to the
ions of the weight of the atmoſphere, various contriv-
have been adopted in its conſtruction. They have been,
e moſt part, attended with difficulties and inconvenien-
ore than ſufficient to counterbalance the advantages
ed from whatever was peculiar in their conſtruction.
inſtruments, ſuch as the *Statical Baroſcope* of Boyle,

have been invented for the purpoſe of eſtimating
weight of the atmoſphere. But, it is ſufficient
have here explained ſimply the principle upon w
mercurial barometer is conſtructed, in ſuch a mann
may be eaſily underſtood by the chemical ſtudent.
panſibility of mercury by a heat which may not act ſ
fect the general weight of the atmoſphere; and the a
and friction neceſſarily exerted upon the mercury by
of the tube in which it is contained; naturally influ
impair the accuracy of the indications of the *baro*
the phyſiology of the atmoſphere, there is no ſ
greater intricacy, than the inveſtigation of the cauſ
produce all thoſe changes in the weight of the atm
that are indicated by the continual riſings and f
the mercury in the barometrical tube. The uſe of
ſtrument, is connected with all thoſe chemical obſ
and experiments, which reſpect the atmoſphere i
changes of its natural ſtate. Whatever experime
be made *ſub dio*, can never be made with due care
ceſs, without an attention to the indications of the
ter. Another curious advantage, not merely to
philoſophy, but to natural philoſophy in general,
to geography, from the uſe of the barometer, is t
it affords for the menſuration of heights and diſt

The Hygrometer.

HYGROMETERS, or inſtruments for meaſuring t
tity of moiſture in the atmoſphere, at any given t
alſo neceſſary to mark the ſtate of the air, when
and phyſical experiments are to be performed in i
are moſt made of ſubſtances liable to ſhrink by dr
a conſiderable degree, and with regular ſteady pa
or to be very perceptibly ſwollen in bulk, when
abſorb even any very ſmall quantity of moiſtu

more particular deſcription of the conſtruction of the hygrometer, belongs rather to the natural hiſtorian or philoſopher, than to the chemiſt.

5. Balance and weights.

III. It is of the utmoſt conſequence in chemiſtry, carefully to aſcertain at all times the quantity of any matter which is ſubjected to experiment, and again, to diſtinguiſh with equal accuracy, the quantities of the products. Hence are the *inſtruments* and the *ſubdiviſions* of WEIGHT, to be regarded as things which merit the young chemiſt's particular attention, before it can be proper for him to enter upon his experimental examination of the ſubjects of this ſcience. BALANCE may be regarded as conſiſting of a *fulcrum* or support,—a *croſs-bar* ſuſtained preciſely at the middle of its length and weight, on the point of this fulcrum,—and *two* scales ſuſpended from the two extreme points of the *croſs*-bar or beam which reſts on the fulcrum. The fulcrum is usually not formed by a pillar riſing from beneath the level of the beam, but by a chain ſuſpended from above, and connected with the middle of the beam by an axis, of which the upper ſurface is formed like the edge of a knife. The centre of gravity of the beam, ought to fall immediately under the fulcrum. It is not of very important conſequence, whether the arms of the balance, be or be not always of equal lengths. But, their relative proportions ought to continue ever invariably the ſame. For the purposes of chemiſtry, it is always neceſſary, that very nice balance be procured. *Weights* for the purpoſes of chemiſtry, are formed by the ſubdiviſion of any particular ſtandard-weight, ſuch as a pound, an ounce, a grain, &c This may be done in the way of continually halving—firſt the particular ſtandard-weight,—then its half,—and ſo on, as far as may be deſired. Granulated lead may be very conveni-

OOK II. ently employed in this operation of halving. A re
way for the ſubdiviſion of ſmall weights, conſiſts in
weighing of a quantity of ſmall wire, and afterwards
ting it into ſuch parts as are required. Thin braſs leaf
be uſed for the ſame purpoſe: As may alſo jeweller's
In philoſophical experiments, it will commonly be f
uſeful to admit but one dimenſion of weights: And
grain may properly enough deſerve the preference.
lances have been conſtructed, by which wonderfully
ſubdiviſions of weight might be correctly diſtingui
Muſchenbroek relates that he himſelf made uſe of a bal
which turned with $\frac{1}{40}$ of a grain. That diſtinguiſhe
tiſt Mr *Bolton*, appears to have had two accurate bal
one of which was capable of weighing a pound, yet w
turn with $\frac{1}{16}$ of a grain.

6.
rnace
d blow-
ɔe.

IV. A FURNACE, in the actual manipulations of che
experiment, is one of the moſt indiſpenſibly requiſite
of all the apparatus of chemiſtry. A FURNACE is ne
more nor leſs than a *chimney* or *veſſel*, into which fuel
be put, and a fire kindled, for the purpoſe of thoſe che
proceſſes in which fire is to be employed as an agent.
ſtructed for other purpoſes than thoſe of chemical operat
common chimnies can rarely ſerve, with due conveni
for any great diverſity of thoſe operations which are
performed by chemiſts with the aid of fire. Furna
peculiar conſtruction, are therefore requiſite. Theſe
be made exceedingly large and capacious, for the pur
of the moſt extenſive manufactures in glaſs or metal
they may be made minutely ſmall, for the niceſt e
ments of the chemiſt. Chemical furnaces, in ge
muſt be ſo conſtructed, as to poſſeſs,—commo
room and *ſupports* for receiving a veſſel or *bath*, con

the matter on which it is wiſhed to bring the fire to
an *aſh-pit* with an *aperture* for its door, by which the
of the conſumed charcoal, may be conveyed away from
fire; *apertures* by which additional fuel may be put in,
time to time,—by which the neceſſary air may be ad-
ed to maintain the combuſtion,—by which the ſtream
ir may be augmented or diminiſhed at pleaſure, ſo as
creaſe or lower the intenſity of the fire within,—by
ch alſo the nozzle of a pair of bellows, may be intro-
ed, to blow it up, when the mere unimpelled ſtream of
is inſufficient to produce this effect. The great objects
ght in the uſe and conſtruction of ſuch furnaces, diffe-
from thoſe of ordinary chimnies, are,—to conſume as
fuel as poſſible,—to apply the heat excited, as directly
as fully as poſſible, to the matter on which it is intend-
o act,—to regulate at pleaſure the degree of its intenſi-
—to have it in one's power, to uſe fire in experiments at
time, and almoſt in any place, without endangering
conflagration of ſurrounding objects which were not
nt to be expoſed to it. The *furnace* for *open fire*, is
ed by a ſingle pot; having one ſquare aperture as a
to the aſh-pit, another above this, for a door to the
place, but which is uſually kept ſhut; having various
ler apertures, deſtined to admit air in greater or ſmaller
tity, as they are at pleaſure opened or ſhut; and be-
ntended to have its ſupplies of fuel introduced from
e. The *moveable* WIND-FURNACE is formed by two
applied mouth to mouth. An iron chimney compo-
of pieces, that its length may be at pleaſure enlarged
iminiſhed, is put on the top of the furnace. A brick
on the grate of this chimney, ſerves to ſuſtain the mat-
xpoſed to the action of the fire. In the upper pot or

dome

dome is an aperture through which the fuel is to be introduced. Two opposite holes in this dome, are destined to receive an iron rod, by which this upper part may be lifted up at pleasure. The *reverberatory furnace* is composed of two pots separated by an iron-hoop, in which is cut an opening or door. It is used chiefly for the purpose of processes of distillation with retorts of earthen ware or coated glass. The *moveable blast furnace* is adapted chiefly for concentrating the heat excited in it, upon a crucible within it, which contains the subject of the process. This is effected chiefly by means of holes bored in the pot obliquely, and all around from the bottom upwards, as far as the upper surface of the fuel. The crucible is destined to stand upon a proper support in the bottom. *Dr* BLACK's *furnace* possesses the advantage of giving to the operator, the command of the augmentation or diminution of the intensity of the heat, in a degree more complete than is to be obtained by means of other furnaces. A *damping-iron* with a sufficient number of holes, which may be shut and opened at pleasure, is the ingenious contrivance by which this is to be accomplished.

The BLOW-PIPE is an instrument for the application of heat to bodies in the small way, by which may be often produced all those effects, which are to be accomplished in the great way by the use of furnaces. It is merely a braſ or silver pipe, about one-eighth part of an inch in its diameter at the greater end, and toward the other, tapering to much smaller size, with only a very small perforation a which the wind may escape. It is bent at the smaller end to one side. It is sometimes fitted with a small bowl, i which the vapours of the breath, may be condensed; an with nozzles, which may be at pleasure applied to the smal

le

its extremity, or removed away from it. The ſmaller extremity of the blow-pipe or its nozzle, is to be applied to the flame of a taper, ſo as to direct it upon the object under experiment. The breath inſpires the pipe; and this blowing, if continued for a ſufficient length of time, will produce an intenſity of heat, adequate to accompliſh upon a ſmall bulk of matter any effect which a furnace-heat is capable of operating upon a larger body. A ſtream of vital air, paſſed through the blow-pipe by means of a bladder at one end of it, will aſtoniſhingly increaſe the activity of the combuſtion, and the intenſity of the heat, at the point where the flame is impelled upon the body under examination.

The combuſtion of fuel, particularly of charcoal, applied in a proper manner in furnaces, is the principal means which art poſſeſſes for commanding any great intenſity of heat. But, the RAYS OF THE SUN concentrated by a convex lens or concave mirror, will alſo produce an extraordinary and aſtoniſhing intenſity of heat.

Baths, &c.

Beſide furnaces and fuel, with other accommodations for the application of the fire it feeds; chemiſtry requires [illegible] other inſtruments and conveniences, in performing its operations by means of heat. Rarely can chemical operations through any wide extent of proceſſes, be performed [illegible] *naked fire* alone, or without the placing of ſome intermediate body between the fire and the ſubſtance on which we wiſh to make it act. This intermediate ſubſtance is called a *bath*. There are *balnea-mariæ* or water-baths, ſand-baths, cinder-baths, dung-baths, &c. Thoſe veſſels into which ſolid ſubſtances are put in order to be expoſed to the action of heat, are ſometimes *crucibles* of baked clay;—ſometimes *cupels*, a ſort of flat crucibles made of the earth of bones;—ſometimes merely capſules of earth or iron.

At times, in the expoſure of ſubſtances to the heat are for particular purpoſes coated over with other ſu ces in the ſtate of powder; and the ſubſtance thus e ed in coating over another, is called a *cement*. The ſels and inſtruments are employed in that claſs of th rations of chemiſtry, which are diſtinguiſhed as pr conducted in THE DRY WAY.

7. Cucurbites and other chemical veſſels.

V. Other veſſels are requiſite for proceſſes which be conducted in the HUMID WAY; that is, for proc which fluid media and fluid ſubſtances are chiefly p *Cucurbites*, or *matraſſes*, are veſſels of glaſs, earth, or ſhaped like an egg, and open at the top. *Retorts* a bular veſſels of glaſs, metal, or earthen ware, with extended in a curved direction from one ſide of the and terminating in an open point or mouth. *T* *retorts* have, beſide the former neck, alſo a neck o ing on the upper part, by which may be introduc them, the matters under experiment. *Receivers* a veſſels, of a ſpherical form, with a ſtraight neck, d to receive from the retorts, the products of the which the matter with which a retort may be charg dergoes. The retort and the receiver are the comm paratus in the proceſs of diſtillation. But, when th ducts are of a peculiarly volatile character, an *al* then to be preferred. This alembic may be of glaſs, or earthen ware. It conſiſts of a *body*, to which is *conical head*: and out of this head deſcends *laterall* to be inſerted into the receiver. Such is the alembic are compoſitions commonly of clay and ſand, uſed t the joinings of different veſſels cloſe, ſo that the p of the operations carried on in them, may not eſca thus diſconcert the proceſs. *Stills* for ardent ſpi

y *alembics* upon a larger ſcale of conſtruction, and ha-
inſtead of a beak entering a receiver, rather a pipe
rm, which is immerſed into a tub of cold water, and
g through this, conveys the ſpirit condenſed by the
out at the lower extremity of the pipe.

5. Operations explained.

The moſt remarkable of the operations performed
l theſe different veſſels and inſtruments, are the fol-
Roaſting is an operation to be performed upon
e ores, by expoſing them in a crucible to the action
in the open air. The volatile parts are thus driven
nd the ore is prepared for a farther analyſis and pu-
n. *Calcination* is *roaſting* carried to ſuch a degree
ſity, as not only to drive off the volatile parts, but
the very ſtate of the fixed parts of the ore. *Fu-*
uces bodies which are ſuſceptible of it,—by means
—from a ſolid to a fluid form. In *reduction* or *re-*
ion, the calces or oxydes of metals are, by means of
ith charcoal or oils, *reduced* to the metallic ſtate
hey loſt by calcination. *Vitrification* is the fuſion
ſubſtances as are capable of aſſuming the bright-
anſparency, and hardneſs of glaſs. *Cupellation* is,
ifying of perfect metals, by melting them with the
of lead, in thoſe veſſels which are named cupels,
oſe porous conſiſtency eaſily abſorbs the lead with
ſs which it carries off with it. *Cementation* is, the
g of the ſtate of particular ſubſtances, by expoſing
the action of intenſe heat, after that you have firſt
them over with a *cement*. *Stratification* conſiſts in
ng ſolid ſubſtances in layers, with intermediate ſtra-
wdered matters, in order to expoſe them, in a cru-
other ſuitable veſſel, to a heat by which their na-
o be changed. *Detonation* is a ſudden change by
heat,

heat, accompanied with conſiderable noiſe, which takes place only on nitre and mixtures into which it enters. *Decrepitation* is a fainter degree of *detonation*. *Fulminating* is a more rapid, vigorous, and noiſy *detonation*. *Sublimation* is the volatilizing of dry, ſolid, and often cryſtallized ſubſtances, by means of fire. *Ebullition* is that change of liquids into vapour, which is occaſioned when they are penetrated by heat to a certain degree of intenſity. *Evaporation* is alſo the converſion of a liquid into a ſtate of elaſtic fluidity, not, however, by the penetration of the whole maſs of liquid by a ſtrong torrent heat, but merely by the action of this heat upon the upper and exterior layers of the maſs of liquid. *Diſtillation* is a proceſs of *evaporation* performed in cloſe veſſels, and ſo as to collect the products. *Rectification* is a ſecond proceſs of diſtillation performed upon the products of the firſt. *Concentration* differs from rectification, in that the former carries off the precious part of the liquid into the receiver; but the latter, volatilizing the leſs precious part, leaves that which is more valuable in greater ſtrength than before, in the cucurbit. *Digeſtion* is the expoſure of ſubſtances which we wiſh to act gently upon one another, to a moderate but long-continued heat. *Infuſion* is the extraction of the more ſoluble parts of certain ſubſtances, by means of hot water poured upon them. *Decoction* is the continued ebullition of water with ſubſtances on which it acts when hot: and is uſed to ſeparate thoſe parts of bodies, which are not ſoluble by a more moderate heat. By *lixiviation*, we diſſolve in hot water, the ſaline and ſoluble particles of cinders, the reſidue of diſtillation and combuſtion, coals, and ſuch native earths as we deſire to analyſe.

9. Pneumatic chemical apparatus.

, in conſequence of the late advancement of
that particular department of the ſcience, which
eumatic *chemiſtry*, becauſe it is employed upon
an aerial or elaſtic-fluid ſtate; a particular ap-
been found requiſite, for thoſe numerous pro-
h are now to be performed on matters in this
. In order to perform proceſſes in which e-
are to be principally concerned, one very ſimple
ſuffice for preſerving air in any veſſel, and for
out of one veſſel into another. Take a wood-
f conſiderable capacity. Place in it a ſhelf for
of jars of glaſs. Then, plunge into the tub,
ater, one or more jars of glaſs. Let them be
he water. When they are filled, invert them,
uth downwards. Although thus inverted, they
ain full, upon the ſame principle upon which
is ſuſtained at its uſual height in the barome-
theſe jars remain thus inverted and full of wa-
ce under their mouths and into their lower ca-
cup or phial or other ſmall veſſel which you
ly plunged into the tub, with its mouth down-
e ſmaller veſſel having been plunged into the
ts mouth downwards, would enter it, full of
ted under the mouth of one of the inverted
give out its air, and will be filled with water.
ping from that ſmaller veſſel muſt neceſſarily
e upper part of the jar, and there diſplace ſo
e water filling the jar as to make room for it-
s the proceſs for emptying elaſtic fluids out of
to another, for the purpoſe of any other pro-
are to be performed with them. If the neck
ing veſſel, be narrow, a funnel of glaſs may be
employed,

employed, to communicate between it and that out of whic the air is to be emptied. A *retort*, in which are containe matters of which the reaction is to afford a product of fo particular gas, may, by means of ſuch a funnel, be ſo co nected with a glaſs inverted in water, as that the form ſhall, through the funnel, pour into the latter, the gaſe product of the reacting matters in the retort, in proporti as it is evolved. A retort intended for ſuch an operati may be made very thin at the bottom, that the flame of candle may act on it without burſting it. For ſupporti any thing at a conſiderable height within a jar, partic *ſtands of wire*, may be employed. The *barrel of a gun*, h ing the touch-hole carefully ſcrewed up and riveted, m be advantageouſly uſed inſtead of an iron retort, in the traction of gaſes out of ſolid matters. Put the ſubject the proceſs into the chamber of the barrel. Fill up th reſt of the bore with dry ſand, thoroughly purified burning, from any air that might remain in it. Let th ſtem of a tobacco-pipe, or any ſmall tube of glaſs, be fixed with putty into the orifice of the gun-barrel. Then put the other extremity into the fire. The gas diſengaged will paſs, of courſe, out at the orifice, through the tube, and may be received into a jar under water, as before. A ſtill more accurate mode of obtaining gaſes from ſolid or other matter, is—to put the matter under experiment into a phial;—over this, fill up the phial with mercury;—in vert, then, the veſſel into a baſon filled with mercury, as in the conſtruction of the barometer;—throw upon its cloſe and upper end, the focus of a burning lens or mirror:— The aerial product, as it is extracted, will occupy the upper part of the phial; and the mercury, to make way for it, will deſcend, as ſoon as is neceſſary into the baſon. Then

by

by a pipe or funnel properly introduced, the gas may be conveyed away, as it is extricated, into a receiver. It will be neceſſary in proceſſes of this nature, to prefer quickſilver to water, particularly for the extraction of all ſuch gaſes as have a tendency to combine with water. To try whether any particular gas be fit to maintain *combuſtion*, introduce carefully into the phial containing it, a bit of a lighted waxen taper, properly fixed upon a wire. For the *meaſurement of the quantities of gaſes*, in order to aſcertain their relative degrees of denſity or rarity, to mark what changes of dimenſions the ſame air may undergo in any particular proceſs, and to know preciſely what portion of an air is uſed in this or that inſtance; uſe a narrow, graduated, cylindrical veſſel. The graduation may be accompliſhed by pouring in ſucceſſion, equal meaſures of water into the veſſel; and marking the exterior ſurface, when each meaſure is poured in, at that particular place at which the upper ſurface of the whole water now ſtands. The EUDIOMETER is an inſtrument which enables us to aſcertain the particular degree of the purity of common air, by mixing with it, nitrous air, in accurate proportions. The principle upon which nitrous air becomes fit for this uſe, will be hereafter explained.

EUDIOMETER.

As water or mercury cannot be employed in the extrication of gaſes from ſubſtances in the ſtate of powder; it may be ſufficient, with theſe, to place them on a ſtand, under the exhauſted receiver of an air-pump, that the gas as it is developed, may be poured into this receiver. The electric ſpark may be made to paſs through gaſes, by means of wires to introduce it through the veſſels in which they are contained, and through the ſubſtances by which they are preſerved in their ſeparate ſtate. *Water may be impregnated with any aerial fluid*, ſuch as *fixed air* or carbonic-acid-

gas,

BOOK II.

gas, by inverting into a baſon of water, a quart-bottl
with the ſame fluid; then, as the fixed air is by a
proceſs procured,—by pouring it through a proper f
into an inverted bottle of water; and laſtly, by agitatin
bottle, till the water ſhall have abſorbed as much gas a
contain. By this proceſs, may natural, aerated waters be a
ally imitated. Dr Nooth's apparatus for the impreg
of water with fixed air, conſiſts of three different ve
glaſs, of which the middle is inſerted at one end in
loweſt, and again, receives into it, the lower extren
that which is uppermoſt. They thus ſtand perpend
ly, one above another. An orifice, with a proper ſt
permits the introduction of the materials which are
ford the required aerial fluid, into the loweſt of the
veſſels. In this veſſel, the gas is diſengaged. The
veſſel is filled with water: but a proper valve preven
water from deſcending into the loweſt veſſel, and y
vents not the extricated air from aſcending into that
is in the middle. The uppermoſt of the three veſſels
empty; nor is the acceſs of common air carefully ex
from it. The air diſengaged in the loweſt veſſel, con
ly aſcends, forces the water from the middle veſſel t
the higheſt, expels the common air out by the ſtop
this laſt, fills it wholly with aerated water, and thus
by a very accurate and ſimple proceſs, whatever quan
aerated water is wanted. The *aerial products of com*
tillation, before the recent improvements in p
tic chemiſtry, were uſually ſuffered to eſcape out at
hole, perforated for this purpoſe in the upper part
retort. More recently, it has been contrived to uſe
tillation, a number of veſſels, arranged one beſide a
and communicating—the firſt by a proper funnel

ooth's
pparatus.

BOOK II.

hich the diſtillation goes on,—this again by ano-
l, with the ſecond,—that with the third,—this,
y, with a fourth,—and ſo on to any number;
care to make the laſt communicate by a ſuitab-
e with an inverted veſſel of glaſs containing mer-
this contrivance, all the products of the diſtilla-
eſerved. The leaſt volatile are condenſed and
the firſt receiving veſſel. The reſt are ſuc-
ndenſed and alſo detained in the order of their
The moſt volatile are at laſt received into the
mercury, which terminates the ſeries. Or, in-
his ſeries of veſſels, we may adopt the ingenious
of Mr Woulfe, which ſwells the body of the
a conſiderable rotundity and capacity; and then
o orifices beſide that communicating with the
e *lower* by which the more denſe and liquid
f the diſtillation may paſs,—another, *higher* up in
of the receiver for the purpoſe of carrying
er pipe and into ſuitable veſſels, thoſe products
in their nature more volatile. The apparatus
Mr WATT, for procuring gaſes in large quanti-
er to medical purpoſes,—conſiſts of—an alembic,
ipe conducting to the *refrigeratory*,—a refrigera-
ſiderable capacity,—a *hydraulic bellows* into which
onveyed from the refrigeratory, that it may be
led,—and laſtly an *air-holder* into which a tranſ-
ſcharges the air from the hydraulic bellows.—A
deſcription of this apparatus by Mr Watt him-
ſeen in full detail in the work of *Beddoes* and
titious Air.

LEMENTS OF CHEMISTRY.

BOOK THIRD.

THE NATURE AND LAWS OF CHEMICAL ATTRACTION; AND OF THOSE DIFFERENT SUBSTANCES WHICH THIS SCIENCE ACKNOWLEDGES AS THE PROPER SUBJECTS OF ITS INVESTIGATIONS.

SECTION FIRST.

THE NATURE AND LAWS OF CHEMICAL ATTRACTION.

1.

ISTRY was defined to be, A SCIENCE WHICH INGATES AND EXPLAINS THE LAWS OF THAT ATTRACWHICH ACTS ONLY BETWEEN THE MINUTE COMPOPARTICLES OF BODIES. Of that ATTRACTION, there a few general laws, ſuſceptible of being clearly aſcered, before we proceed to diſtinguiſh the different ſorts mical ſubſtances. Theſe are laws univerſally appli- forming the chief grounds of diſtinction, upon the moſt general claſſes of chemical matters, are to ed and characterized; being, in fact, the moſt geneults of the whole maſs of chemical obſervations and iments which have been made by mankind, ſince the ing of time.

The general laws of chemical attraction are the grounds of the diſtinction of chemical ſubſtances.

ATTRACTION is of two ſorts; that which acts bemaſſes of matter, in the ratios of their quantity, and

of

2. Chemical diſtinguiſhed from Mechanical attraction.

of the ſquares of their mutual diſtances; and that, again, which acts only between the *minute, component particles* of bodies brought into actual contact, and is therefore called *chemical attraction.* The former attraction regulates all the great motions of the univerſe, and is the ſubject of every branch of mechanical philoſophy. Its phœnomena every where ſtrike the ſenſes more obtruſively than thoſe of chemical attraction. But, even of this latter, the natural indications are ſufficiently frequent and obvious, to force themſelves upon the notice of the moſt careleſs obſerver.

3. Laws of chemical attraction.

The following are the general laws of chemical attraction.

FIRST LAW.

I. It is the firſt law of chemical attraction; that, *All homogeneous bodies, or bodies of which the minute component particles are perfectly ſimilar to one another, have a natural tendency to remain in contact, until they be ſeparated by the action of ſome ſuperior force, mechanical or chemical.* The chemical attraction deſcribed in this law, is called The *attraction of aggregation.* It takes place in the inſtances of ſtones, wood, ſnow, water, air, &c. Any body of which the parts are held in union by this ſpecies of chemical attraction, is called an *aggregate.* A *heap* differs from an aggregate, in being an accumulation of ſmall bodies ſimilar to one another, but not coherent. A *mixture* is a collection of ſmall bodies, diſſimilar to one another, and alſo without coheſion. A *mixture by confuſion,* is produced when two heaps, ſuch a one of flowers of ſulphur, and one of nitre in powder; ar confuſedly blended together. Rock cryſtal, wood, glaſs diamonds, and other homogeneous bodies of a ſimilarly ſolid and coherent conſiſtency, are named *hard aggregates* *Soft aggregates* are thoſe of which the component parts may be moved backward and forward with the finger almoſt withou

ffort. Of this ſort are ſnow, ſoft ſoap, and other
a like conſiſtency. Water, wine, beer, and milk
aggregates. All ærial matters are denominated
ggregates. Theſe different ſorts of aggregation
many different degrees of the ſame force; which
ſt in the *hard*, and weakeſt in the *æriform* aggre-
heſe ſeveral aggregations ſubſiſt, as we ſee, in na-
t can, for the moſt part, both deſtroy and reſtore
pleaſure. In reſtoring any bodies to the ſtate of
regation, art can generally manage its proceſſes, ſo
n the body in its hands either into an irregular
into ſo many *cryſtalline* forms, bounded by regular
les, and ſurfaces. This laſt ſort of change from
o the *ſolid* ſtate, is called *cryſtallization*.

SECOND LAW.

the other chemical attractions are called *attrac-*
mpoſition. They take place between bodies of
component particles are reciprocally heterogene-
hen ſugar is diſſolved in water, when wine and
mixed together, when water is evaporated by
on with heat.

herefore, the ſecond law of chemical attraction;
attraction of compoſition can take place only be-
ies which are different in their nature. The at-
f compoſition is, in truth, never ſtronger, than
bodies between which it acts, are, in nature, the
ially different from one another. Acids and al-
s perfectly oppoſite to one another in their pro-
nter into the moſt intimate mutual union. Al-
ſulphur, acids and oils, acids and metals, water
of wine are, in the ſame manner, exceedingly op-
one another in their qualities, yet diſpoſed to
together with remarkable energy. Nothing can

BOOK III. SECT. I.

ture. It is obviouſly occaſioned by the abſorption engagement of ſubſtantial heat.

SEVENTH LAW.

VII. *The properties of the compound formed when or more bodies enter into combination by means of the attra of compoſition, are entirely different from the properties were poſſeſſed by the ſeveral bodies before their union.* Th the ſeventh law of chemical attraction. It was not niſed by Stahl and his firſt diſciples. Meſſrs Bucq Fourcroy were the firſt chemiſts whoſe reſearches led to affirm this to be one of the laws of chemical attra By a vaſt multitude of obſervations and experiment has been demonſtratively aſcertained, that, in taſte form of cryſtallization, in conſiſtency, in odour, in ſo lity, the character of compounds is always eſſentially ferent from that of their component principles. Ca bodies often loſe their cauſticity, in combination: ſu ces which when ſeparate exhibited no cryſtallization combined, appear only in cryſtals: fluid ſubſtances wi come by combination ſolid; and ſolids, fluid: Inodo matters often become in combination ſtrong-ſmelling fuſible ſubſtances, when combined, often acquire the lity of fuſibility. Innumerable are the other ſtriking entire changes of properties which take place in comb tion.

EIGHTH LAW.

VIII. The eighth law of chemical attraction exp that, *the attraction of compoſition is meaſurable by the di of deſtroying the combination formed by it, between two bodies.* The eagerneſs with which ſubſtances ente combination, ought never to be regarded as any ſure of the ſtrength of their mutual attractions for one Subſtances which enter the moſt rapidly into un often the moſt eaſily ſeparated. But, the degree

dit

difficulty which is found in detaching any two ſubſtances out of that combination in which they are united, are an infallible meaſure of the force of their mutual attractions. This is obvious to any perſon's conſideration. It has been invariably confirmed by all the experience of chemiſts.

Ninth Law.

IX. By the ninth law of chemical attraction it is determined, that, *different ſubſtances poſſeſs in different degrees, the power of chemical attraction, in regard one to another; and that the degrees of this force ſubſiſting between any two ſubſtances, may be determined by obſervation and experiment.* There are ſome bodies which art cannot by any known means, bring into combination. Iron and mercury, for inſtance, water and oil, are certainly not without ſome degree of mutual attraction for one another; but we cannot bring them to unite. Again, the whole range of chemical obſervation evinces, that, in nature, chemical ſubſtances are continually detached out of any combination in which they may be more looſely connected, whenever other ſubſtances preſent themſelves with a more potent attractive force, to create ſome new compound. All the operations and experiments of chemiſtry are founded upon this idea; that the degrees of the attractive force with which different ſubſtances tend mutually to combine, are infinitely diverſified. All that has been as yet done by chemiſtry in inveſtigating the nature of material bodies, has been only to aſcertain a comparatively ſmall number of the immenſe diverſity of *elective* attractions of different ſubſtances for one another. Chemiſts have called theſe attractions *elective*, becauſe chemical ſubſtances ſeem, as it were, to chuſe one another out for cloſe combination, with mutual preferences, which are not unaptly to be compared to the choices made by thinking beings. Let, for inſtance, any two bodies,

bodies, ſuch as an acid and a metallic oxyd, be combined by a force of mutual attraction equal to *four*. Then bring into contact with this compound, a third ſubſtance, ſuch as an alkali, tending to combine with the acid by a force of attraction equal to *ſix*: The conſequence will be, that the acid deſerting the oxyd, will enter into a new combination with the alkali; and the oxyd will be left in a free and ſeparate ſtate. This is the operation of *elective* attraction.

TENTH LAW.

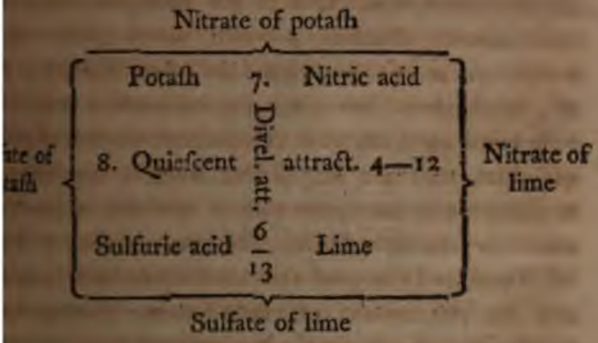
X. The tenth law of chemical attraction is; that, *all particles of matter which are ſuſceptible of union by chemical affinity, tend continually to form bodies of a polyhedral, conſtant, and determinate form.* One of the moſt beautiful and the moſt univerſal phænomena which natural hiſtory and chemiſtry have traced throughout the material world; is that of *cryſtallization*. We never ſee any matters combine into bulk and magnitude from the minuteſt diviſion of particles of which they are ſuſceptible, without perceiving that combination to take place with a tendency to ſome determinate regularity of form. The great *Linnæus* of Sweden, M. Romé de Lille, and the Abbé Hauy have happily traced the phænomena of cryſtallization through a vaſt multiplicity of inſtances. No contradictory general fact has been obſerved Whether conſolidating from a ſtate of fuſion, or from a ſtate of ſolution, bodies ſtill tend to regularity of form. It is with great propriety, that M. Chaptal has added this to the other laws of chemical attraction.

4. Manner in which double attractions act.

THESE are all the known general laws of chemical attraction. It is not difficult to conceive, how theſe laws muſt act in that ſimple caſe, in which only two ſubſtances are ſuppoſed to be preſented to one another, and to enter

into

union. But, this rarely happens, either in nature, or the laboratory of the chemiſt. Compounds are uſually ught together, to decompoſe one another, and produce compounds by the power of the elective attractions the ſeveral ſimple ſubſtances. The manner in which attractions then act, may be beſt expreſſed in ſome h table as that below. *Sulfate of potaſh*, and *nitrate of* , are two neutral ſalts neither of which can be decomed by either of the two ſimple principles in the other, eparately applied to it. But, let the two compounds brought together in ſolution, a reciprocal compoſition then take place in this manner.



this example, thoſe attractions whoſe force tends to the two ſalts in their original combination, amount : the potaſh and the ſulfuric acid being held togein the ſulfate of potaſh, by the attraction of 8 : and itre and the lime being held together in the nitrate e by the attraction of 4. Such is the ſtate of the attractions acting in this ſolution, in order to prethe neutral ſalts the ſame as they were at the firſt. on the other hand, the potaſh is drawn to combine he nitric acid by an attraction of 7; while the ſulfuric

OOK III.
Sect. I.

ric acid and the lime have for each other a mutual attraction of 6; ſo that the ſum of theſe ſecond two attraction is equal to 13. The ſum of 13, the whole force of th attractions tending to form two new neutral ſalts in th ſuppoſed ſolution, exceeds the ſum of 12, the attraction tending to prevent that change. The old ſalts are therefore decompoſed, and the new ſalts are formed, as is repreſented in the table above. This is an example of th moſt intricate of thoſe attractions which uſually take plac in the chemical changes of bodies. It happens not unfrequently, that, of three ſubſtances, two in combination, a one ſeparate, there ſhall be an attraction between the ſubſtance which is ſeparate, and one of thoſe which are combination, ſufficiently powerful to decompoſe the o compound, and form a new one. But, the learner m without much difficulty, form to himſelf a clear idea what takes place in this inſtance. Every obſervation ſhall hereafter have occaſion to make, every experim he ſhall witneſs or perform, will not fail to make th matter continually more clear to him.

It is ſcarcely neceſſary to obſerve farther concerni theſe laws of chemical attraction; that the eight laſt ſtrictly ſpeaking, but ſo many different modifications the ſecond. They might be all reduced to two; one aggregation; another for compoſition.

SECT

...ARRANGEMENT OF THE SUB- ...MISTRY;—DISTINGUISHING THEM ...CLASSES, ORDERS, GENERA, AND SPE-

...III.

BOOK III
SECT. II.

...eral Laws of Chemical Attraction, explained ...going Section, reſpect material exiſtences in ... We are, henceforth, to trace thoſe Laws in ...cular applications to the various ſubſtances upon ...miſtry is to be employed. Theſe may be ar- ...Claſſes, Orders, Genera, and Species.

...SIMPLE *Subſtances*, or rather *Subſtances which* ... *as yet, decompoſed*, may be regarded as the ... of ſo many diſtinct CLASSES.

...are—Caloric, Lumen, Oxygen, Hydrogen, ...Carbon, Sulphur, Phoſphor; Muria, Borate, ...ce, Alumina, Baryt, Strontiana, Lime, Mag- ... Soda, Adamantina, Ceylonica; Arſenic, Tungſten, Manganeſe, Nickel, Cobalt, Biſ- ...mony, Zinc, Iron, Tin, Lead, Copper, Mercine, Acete, Tartare, Pyro-Tartare, Oxale, tre, Malle, Benzoe, Pyro-Ligne, Pyro-muce, Lacte, Saccho-lacte, Forme, Pruſſe, Sebace, Bombe; the Sulphures, Carbures, Phoſphures metallic Oxydes and amalgams, with all the dro-carbonous compounds, however differing in the ture, from the acid baſes of a ſimilar origin; unions of the ſimple earths with other ſubſtances are believed to be of equal ſimplicity. Theſe pear to conſiſt, ſimply, of two principles. But, mation is inaccurate, by which they are thus Even the Fields, may, with ſome inaccuracy, raigned with them.

The COMPOUNDS of theſe COMPOUNDS, are the NERA. Such are the NEUTRAL SALTS,—many IMMEDIATE PRINCIPLES of *Animals* and *Veg* &c. &c.

The SPECIES are, in every department of Nat and Art, the ſubordinate compounds of theſe GE more complex, yet regular in their compoſition.

The VARIETIES of theſe SPECIES, are extreme merous. The INDIVIDUALS comprehend all the complex, chemical combinations, whether of Nat Art.

Such is the moſt orderly plan of arranging the of Chemiſtry, agreeably to the received Laws of Abſtraction. In the following part of this plan of arrangement is to be followed,—not with nient and pedantic rigour,—but with ſuch devi appear neceſſary to eaſily intelligible explication.

The FOURTH BOOK, immediately ſubſeque bits the *Chemical Hiſtory* of thoſe leading

ELEME

ENTARY Subſtances,—Light, Caloric, Oxygen, and
ogen,—with thoſe of their immediate compounds,
conſtitute ORDERS.

E FIFTH BOOK gives the hiſtory of all thoſe Simple
nces which, in their combination with Oxygen, afford
Such are,—Azote, Carbon, Sulphur, Phoſphore,
, Borace, Fluore.—There follows a deviation from
ſcientific order of arrangement, in the introduction
hiſtory of the *compound* Acid baſes, immediately
hat of the *Simple*. Theſe compound *Acid baſes* are,
ne, Acete, Tartare, Pyro-Tartare, Oxale, Galle,
Malie, Benzoe, Pyro-Ligne, Pyro-muce, C[illegible],
Lacte, Saccho-Lacte, Forme, Pruſſe, Sebace,
Bombe. Of theſe, ſome are *binary*, ſome *ternary*
unds. They are diſpoſed in the ſame Book, with
mple acid baſes, ſolely becauſe it ſeems likely, that
place, their hiſtory may the moſt eaſily lead the
to underſtand the true nature of the Acids. The
of the Acids is given with their baſes.

SIXTH BOOK joins to the hiſtory of thoſe *Simple*
nces, which are denominated Earths and Alkalis,
tory, alſo, of *Ammoniac*, that compound ſubſtance
is, alſo, regarded, as an alkali. With theſe, for
e of convenience of explication, it gives the hiſtory
hoſe *Neutral Salts*, in the formation of which, Al-
ombine with Acids.

SEVENTH BOOK gives the Hiſtory of the Simple
nces known by the common name of METALS,
hat of the Orders, Genera, and Species of the me-
Compounds.

BOOK, is given the hiſtory of various
and *ſpecific*, which required to their
proper

proper explanation, a length of details, ſuch as would have made their earlier introduction in the courſe of the Work, not a little perplexing and inconvenient. Such are, the Chemical hiſtory of Diamond, Oils, Bitumens, Pit-coal, Peat, with the account of all the *immediate* principles of animal and vegetable matters in general.

To the NINTH BOOK, deſtined to cloſe the Work, is referred, the application of the principles of Chemiſtry to explain the Origin and Structure of the Earth,—the Vital and Organic functions of Animals and Vegetables,—the beſt practice of Agriculture,—and the ratio of a number of the principal, Chemical Arts.

Several other things, of importance, tho' not eaſily reducible into the ſituation of parts of a ſyſtem, are referred to appendices. One of theſe is, a more particular account of the Old theory of *Phlogeſton*, than could be conveniently given in the introductory hiſtory of Chemiſtry. Proofs of the acquaintance of the Engliſh Philoſophers in the laſt century, with the *Lavoiſierian* Theory, fill a *ſecond* article of Appendix. A *third* is employed in explaining a *Theory* which will, ſoon, probably, attain to the dignity of demonſtrated ſcience, and which repreſents LIME as Oxygen in a concrete ſtate, and the two fixed Alkalis, as of a kindred nature. Some poſitions of the ingenious COUNT RUMFORD, are conteſted, and refuted in another Article of Appendix. Another is employed to explain the proofs of the Compoſition of the *Electric Fluid.* The General *Table* of Chemical Subſtances which was conſtructed by the French Chemiſts, is, here, introduced with ſuch variations as the new diſcoveries, ſince its firſt conſtruction, appeared to render indiſpenſibly neceſſary.

New diſcoveries made public between the time of the [illegible] of the firſt part of this work and that of the ſecond, has been introduced in its progreſs. In one or two inſtances, therefore, an old doctrine that has appeared towards the beginning is ſupplanted by a new doctrine toward the end.

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ELEMENTS OF CHEMISTRY.

BOOK FOURTH.

OF SOME SIMPLE AND NON-ACIDIFIABLE SUBSTANCES, WHICH ABOUND ALIKE IN ALL THE KINGDOMS OF NATURE.

SECTION FIRST.

LIGHT.

BOOK IV.
Sect. I.
1.
Phyſical properties of light.

LIGHT is a ſubſtance of which chemiſtry has been, hitherto, little able to explain the nature. It communicates to the human mind, through the ſenſations of ſight, the tions of diſtance, form, and colour. It ſeems to proceed inceſſant diffuſion from the ſun and the fixed ſtars; to ve commonly in ſtraight lines; to be continually abſorb, reflected, or refracted by all the non-luminous bodies which it comes into contact. Its motion has been tained by the moſt eminent aſtronomers, to be at the of 167,000 geographical miles in a ſecond of time. ys continually either diverge from the ſame common , or converge towards it; never moving in perfectly llel directions, in regard to one another. Such is its city, that the angle of its reflection from opaque ſurs nearly equal to the angle of its incidence. All

other

other material bodies are in reſpect of light, either
rent or *opaque*. The *tranſparent* are thoſe through the
of which the rays of light are eaſily tranſmitted, ſo a
luminate bodies beyond them. The *opaque* are
through which light does not penetrate, but which
and abſorb it. Air, glaſs, and ſome other ſubſtance
tranſparent character, tranſmit light without refract
But, the greater number of tranſparent bodies re
from the ſtraight line under a certain angle, as it
through them. Incombuſtible tranſparent bodies
the rays of light paſſing through them, in the direct
of their reſpective denſities. Combuſtible bodies
light, in the direct ratio of their combuſtibility. It
in its paſſage out of a thinner into a denſer medium,
this refraction of light takes place. Other ſubſtance
pelled out of a thinner into a denſer medium, are, i
ſequence of this, liable to recede ſtill farther and
from the direction of a line drawn perpendicular t
point from which their motion commenced: But, lig
the contrary, in its refraction, always converges m
leſs backward, towards this perpendicular.

2.
analyſis
the
iſm.

Every ray of light, when indecompounded, diſplay
one lucid *white* colour; but, is ſuſceptible of a deco
tion by which this *white* is reſolved into ſeven diſti
lours. Theſe are red, orange, yellow, green, blue,
and violet. This decompoſition is not effected by t
either of mechaniſm, or of chemical analyſis, but
mode of reaction peculiar to light itſelf, and not y
ciently underſtood. Paſſing athwart falling rain, t
of light ſuffer a ſimilar decompoſition; and hence
in the rainbow, analyſed into their ſeveral primary c
Of opaque and tranſparent bodies, very many d

in part the rays of light, while they reflect or refract them. Upon this partial decompoſition of light, effected in different ways by different ſurfaces, ſeems to depend all that diverſity of colours which diſplays itſelf to the human eye in the material world. One opaque ſurface reflecting the rays which fall upon it, undecompoſed, is therefore *white*; another abſorbing whatever light falls upon it, is conſequently *black*; a third abſorbing all the primary colours in the light to which it is expoſed, ſave blue, appears for this reaſon to be of a permanent *blue* colour; and it is thus of all the other colours exhibited by material bodies.

3. Its chemical character and agency.

Although we cannot venture to affirm of the priſmatic analyſis of the rays of light, that it is produced by any chemical agency; although we know only, that the ſeven different primary colours are ſubject to ſo many different laws of refraction and reflection; yet nothing can be more certain than that light acts the part of one of the great chemical agents of nature. *The ſun, while it illuminates this planetary ſyſtem, probably accompliſhes an unceaſing fixation of light in an infinite number of other material bodies: And it is, on the other hand, not improbable, that light,—or perhaps rather its elementary principles far more ſimple than itſelf,—is continually evolved from innumerable bodies in nature, in which it has been previouſly fixed, and is thus reſtored to renew the ſubſtance of the ſun, out of which it is to be again effuſed abroad.* Its extreme elaſticity, tenuity, and levity are exceedingly favourable to this ſuppoſition. Light is ſo generally perceived only in combination with caloric, that we dare ſcarcely venture to ſpeak with confidence of its ſole and peculiar effects in chemical combinations. But, there is no ſubſtance in nature that can be, for any length of time, expoſed to its action without ſuffering, in conſequence, a chemical

BOOK IV. Sect. I.

mical change. Plants are known to owe to the i ence of light, much of their colour, conſiſtency, o and ſapidity. Vegetables and fruits, the produce of mates in which the influence of the ſolar light is the conſtant and intenſe, are, from this cauſe in general, r more ſapid, odorous, reſinous, &c. than ſuch as gro latitudes remote from the equator, and on which the nial light of the ſun is much leſs uniformly and power exerted. Expoſed to the ſun's rays, the leaves of l vegetables evolve copious ſtreams of vital air: Hid i the influence of light, the ſame leaves give out carb acid. The light of the moon, in union with which t is little or no heat, is well known to contribute emin to the ripening of fruits and grains. All metallic o are ſubject to aſſume a deeper ſhade, in conſequence o ing expoſed in cloſe veſſels to the action of light. P ers' colours kept in windows and in veſſels of glaſs, a a good inſtance of this general fact. Mineral acids e ed to the ſun, become fuming, brighter in colour, more volatile: Metallic ſalts, under the ſame action, come black: Animal oils are made by it, to aſſume a b duſky hue.

4. onjectural the[illegible] its action upon coloured ſubſtances.

Is it not probable, that all *coloured bodies are liable t dergo a change of colour by the operation of light long falling them.—ſolely becauſe thoſe primary colours in the ray, w they abſorb, enter by chemical attraction into continual combin with thoſe different primary colours which they already co until there is again compoſed under certain laws, a perfect light or colour, in which all the ſeven primary colours exi gether?*

SE

Of Caloric.

SECTION SECOND.

OF CALORIC.

BOOK IV
Sect. II.

1.
Phyſical characters of *heat*, or CALORIC.

Our feelings inform us of two different ſtates of the atmoſphere by which we are ſurrounded, and of all material bodies expoſed to our contact; of which we are accuſtomed to denominate one *hot*, the other *cold*. The degrees in which different bodies make themſelves known to our ſenſes, as hot or *cold*, are endleſsly varied by an infinite diverſity of circumſtances. In the rays effuſed from the ſun, in the focus of a burning-glaſs, in fires artificially kindled upon the earth, in the craters of volcanoes, *heat* ſeems to our ſenſes to be, in ſome ſort, materially preſent, not as a quality, but as a diſtinct and peculiar ſubſtance. To the maintenance of that *heat* which is artificially produced by kindling fires, ſome bodies are incapable of contributing any thing: and theſe are therefore termed *Incombuſtible*. Other bodies are neceſſary to maintain the heat of artificial fires, and are themſelves diſſolved while they ſupport it. Theſe are named *Combuſtible* bodies. It is by our ſenſe of *feeling* alone, that the preſence of *heat* is made known to us. But, when evolved in the ſtate of the greateſt ſimplicity and purity of which it is apparently ſuſceptible, it is ſtill blended and intimately combined with light, in a manner which renders them, to the eye, undiſtinguiſhable from one another, or rather, which makes *heat* abſolutely inviſible. Philoſophers, at a time when ſcarcely aught but mechanical philoſophy, was applied to phyſics, were inclined to conſider heat in material bodies, rather as a modification of contexture and of the inteſtine motion of the parts, than as a peculiar

BOOK IV. S. ſubſtance in nature. The progreſs of natural hiſ of philoſophical chemiſtry, has gradually explode errour.

In Electricity, in which conſiſts *one grand mod* of this ſubſtance of *heat*, it is ſubject to a peculiar laws; laws which cannot be reduced under the ana the principles of either chemical or mechanical phil In its *only other great modification*, the relations of it tence and operation, appear to be chiefly chemica to its ſubjection to the general laws of *gravitation*; we only, that if it poſſeſs not the quality of abſolute *lev* at leaſt the *lighteſt* of all material ſubſtances.

2. Degrees of heat how meaſured.

Various means have been naturally and happily e ed to aſſiſt the imperfection of our ſenſations, in j of the different degrees in which bodies are liabl hot,—or of the different quantities of heat, more which, in conſequence of a diverſification of circumſ are liable to be, at different times, preſent within th extent of ſpace. Our feelings, unaided, afford but v accurate information concerning this matter; becauſ indicate the preſence of *heat*, only when the matte ſented to them, are *hotter* than the actual *temperature* bodies. When thoſe matters are preciſely of the ſam *perature* with our bodies, we are not ſenſible of the p of heat in them: When their temperature is leſs be that of our bodies, their contact gives us what is call ſenſation of *cold*. Its effects upon material bodies in ral, which are eaſily viſible to us; afford more preci determinate indications of the degrees of its intenſity can be derived from our feelings alone. One deg heat, for inſtance, maintains water and other liqu their fluid ſtate: A heat more intenſe deſtroys the c

Natural meaſurement.

[illegible] of animal and vegetable ſubſtances: An increaſed degree of this ſame heat reduces liquids to a ſtate of elaſtic fluidity: A yet more intenſe heat is required to reduce metals to fuſion: The moſt intenſe heat known, is that which, in an inſtant of time, burns, calcines, and vitrifies all bodies ſuſceptible of combuſtion, calcination, or vitrification.

Artificial meaſurement.

[illegible], in order to attain yet greater preciſion in aſcertaining the degrees of heat, than theſe indications ariſing from its effects upon various natural bodies, are able to furniſh; philoſophers and artiſts have found it neceſſary to employ the inſtruments before deſcribed, the thermometer and the pyrometer. After the trial of various ſubſtances incloſed in tubes of glaſs, in order to indicate, by the effects of external heat upon them, in what degrees it ſubſiſts in the bodies to which they are thus applied; mercury has been at laſt univerſally preferred, as that which affords the moſt accurate indications, and admits of the moſt extenſive ſcale. The three thermometers of Fahrenheit, Reaumur, and Celſius, have been above deſcribed. But, with the thermometer, it is obviouſly inconvenient to meaſure the degrees of any heat more intenſe than that at which liquids are reduced to a gazeous ſtate. Muſchenbroek invented his pyrometer which meaſures the degrees of intenſe heat by the expanſion of a bar of iron; *Wedgewood*, his pyrometer which meaſures heat with great accuracy by the ſhrinking of a plate of baked porcelain-earth; M.ſſ's *Lavoiſier* and *de la Place*, one which affords ſimilar indications by means of the melting of ice in cloſe veſſels; all for the purpoſe of aſcertaining the gradations of that exceſſively intenſe heat which the thermometer cannot be conveniently made to meaſure. Theſe different inſtruments, thermometers and pyrome-

ters,

ters, all degrees of heat are meaſurable—from that a mercury is ſubject to freeze, to that by which tl refractory and indeſtructible of metals, is liable to cined.

3. Chemical examination of heat.

Natural hiſtory, mechanical philoſophy, and tha inaccurate knowledge which anſwers the ordinary p of common life, may be content with ſuch knowl the uſes of *heat* in the changes of nature, as has bee conciſely ſtated, and as may be acquired by the mea mentioned. Chemiſtry examines it much more par ly, and alone exhibits a full explanation of its true ter and action.

4. The name of *caloric* preferable to that of heat.

In its eſtimation of the nature and relations of he miſtry conſiders this ſubſtance, as exiſting among ot tural bodies, in the two different ſtates of *free* and *co* or in other words, as *perceptible* to the ſenſes or *latent* *heat* is a term of popular language, which has been quently uſed, without correct preciſion of ſignifi thoſe chemiſts who have lately laboured with th ſucceſs, to exalt their ſcience to the dignity of true ſophy, and the beauty of analogical nomenclature rangement; have been induced to reject the term rather to denominate this ſubſtance by that of CA which alone, therefore, ſhall be uſed in the followi ragraphs of this ſection.

5. Of free, uncombined CALORIC.

I. CALORIC, then, in its FREE ſtate, diſplays wi energy, all its peculiar qualities. It dilates almoſt dies, and holds, as it were, their component parts ſu ed in itſelf, with degrees of dilatation which diffe one another, as to the rapidity with which they are ted, in direct proportion to the differences—of th ſpective attractions of aggregation,—and of the qua

oric reſpectively applied to them. This dilatation is
the direct ratio of the *rarity*, or the inverſe ratio of
ſity of bodies. The bodies dilated, undergo this di-
in all their dimenſions, and throughout all their
Of thoſe bodies which are in nature or by art, ſub-
o the action of free caloric, ſome remain unaltered
ts energy. Rock-cryſtal, however long expoſed to
ion of free caloric, loſes neither its hardneſs nor
rency, but appears, after the aſſay, in all its former
and beauty. Far the greater number of bodies are
ſubject to have their aggregation entirely deſtroyed
action of caloric. In ſolids, this total change of ag-
on is called *fuſion*: And by this *fuſion* ſolids are re-
either to a *running* or to an entirely *liquid* ſtate.
undergoing a ſimilar change by the action of free
are reduced to what is called a *gazeous* or *elaſtic*-
nſiſtency; and the act of the change thus effected
hem is named *evaporation*. Various bodies ſuſcepti-
fuſion, are incapable of being *evaporated*: Theſe are
iſts ſaid to be *fixed*; while, on the other hand, bo-
ſceptible of *evaporation*, are termed *fluid*. Free *calo*-
ether acting in art or in nature, is the moſt power-
all chemical agents, and in its agency the moſt ex-
It is employed by chemiſts to ſeparate fuſible from
, fluid from ſolid, evaporable from fixed,—combuſ-
m incombuſtible—ſubſtances. *Combuſtion*, one of
teſt phænomena in which caloric is concerned, will
be explained in a ſubſequent ſection. It promotes
ual *combination* of all ſubſtances to which it is ap-
reciſely in the ſame proportion in which it perpe-
nds to diminiſh and overcome their attraction of
ion. Applied, not to produce a ſudden and en-
tire

[illegible] dies, by exceſſive
[illegible] entle and long-con
[illegible] an internal movem
[illegible] ably altered in their
—by which ſolids are gr
[illegible], and confiſtency. Eq
[illegible] are reſpectively ſuſceptib
[illegible] quantity of caloric, more
[illegible] an entire change of
[illegible] ity in each differ nt mat
[illegible] *pacity of caloric*. The q
[illegible] this ſpecific capacity in e
[illegible] the *ſpecific caloric* of that body
[illegible] ard to their ſubjection to the
[illegible], the *fluid or liquid*, and

[illegible]

[illegible] miſts have diſcovered, that,
[illegible] h all material nature, [illegible]
[illegible] ers in innumerable [illegible]
[illegible] which its qualit[illegible] a ſimple ſub
[illegible] the known laws of chemical comp
[illegible], in theſe new properties which
The action of *caloric*, in its free,
[illegible] indeed, with [illegible] propriety, un
[illegible] on; becauſe the diſtinctions betwee
[illegible] ſtate, cannot be, otherwiſe, ſatisf
[illegible] But, that action nevertheleſs dep
[illegible] the mechanical properties of this ſubſtan
[illegible] attraction of gravitation, ſcarcely at all upo
[illegible] attraction. The illuſtrious Dr Josh
[illegible], firſt made known to chemiſts th
[illegible] in a combined ſtate. To this [illegible]

then known ſolely by the denomination of *heat*, he ap- the term—*latent heat*. All gazeous and fluid bodies are permanently ſuch, probably contain *caloric* inti- ly combined in their very compoſition. Although do not, upon bare contact, affect our organs with the tion of *heat*; yet when decompounded, they uſually out various quantities of *caloric*; which then, either about in a free ſtate, or elſe enters again into new binations in which its peculiar qualities become *latent*, fore. Even various ſolid bodies, ſuch as quicklime the cauſtic alkalis appear to give out caloric, while enter into new combinations; and muſt, therefore, as ſhould ſeem, contain caloric, when they are in the cauſtic . It is certain that light and caloric exiſt very general- ther in mixture with each other, or in a ſtate of mutual combination, in which both the ſimple ſubſtances appear pectively to retain moſt of their peculiar properties. But, laws of this mixture or combination of light with heat, as yet far from being diſtinctly and ſatisfactorily known. The different ſubſtances thus ſuſceptible of combination with caloric, enter into this combination, in different orders elective attraction. Some ſubſtances adhere to caloric, tenaciouſly; others, by a ſlighter and looſer connexion: detach caloric from one another; others abſtract each from combination with caloric. Theſe elective at- tions of different matters for caloric, will be ſucceſſive- plained in the ſubſequent progreſs of this work.

7.
Summary recapitulation of the chemical characters of caloric.

There is, in general, every reaſon to induce us to regard preciſely in the ſame light, as any other chemical ſtance, ſimple and peculiar in its character. We ſee it both as a *mechanical*, and as a *chemical* agent. We per- it to be hidden, like other ſimple, chemical ſubſtances, in [illegible] out of which it may be made to ſtart [illegible] into a new exiſtence, and ſuddenly to array [illegible] proper qualities. In ſome combinations, [illegible] with ſuch pertinacity, that it is not eaſily [illegible] them. Out of others, its evolution can [illegible] difficulty procured, even by the operation of [illegible] attractions of no extraordinary ſtrength. Concern [illegible] the relations between light and caloric, in particular, it [illegible] certain, that theſe two ſubſtances generally diſplay them[illegible] ſelves together; that they aid each other's action; th [illegible] tranſparent or red hot veſſels of glaſs or other matter [illegible] being permeable to light, are, on this account, the [illegible] favourable to the operation of caloric in chemical proce[illegible] that all dark-coloured bodies abſorb and conduct calo[illegible] more rapid and effectually than thoſe which are light [illegible] pale in their colour.

Chemiſts have never yet accuſtomed themſelves to diſting[illegible] upon all occaſions, with due accuracy and preciſion, between th[illegible] MECHANICAL and the CHEMICAL agency of caloric. Th[illegible] neglect is the ſource of very many errours.

SEC

SECTION THIRD.

OF OXYGEN.

1.
Oxygen is obtained from the atmoſphere.

THAT thin, inviſible fluid which floats every where, around us, and which we name the *air*, or *atmoſphere*, is not, as may ſeem to vulgar obſervation, a ſimple, uniform ſubſtance. It is a compound, or a mixture of many gazeous matters, which are continually formed in itſelf, or poured into it from the earth and waters over which it is ſuperincumbent. Among theſe, *vital air*, or *oxygen gas* is one of the moſt remarkable; one which enters, at all times in a conſiderable proportion into common atmoſpheric air. This gas oxygen, analyſed by chemical proceſſes founded upon a knowledge of the elective attractions to which its principles are ſubject; affords, as its principal conſtituent part, that ſimple, undecompoſable ſubſtance, which is known in modern chemiſtry by the denomination of OXYGEN.

2.
Alſo from various other matters.

Nor is it ſolely from the atmoſphere and from *vital air* or *oxygen gas*, that *oxygen* is to be obtained by the proceſſes of chemiſtry. It is extracted out of innumerable other bodies in nature, both fluid and ſolid, out of the *oxyds* of metals, out of *water*, out of all thoſe compound, chemical ſubſtances which we ſhall ſoon have occaſion to know under the denomination of *acids*, out of all *burnt* bodies, out of all thoſe more complex matters into which any of thoſe ſimpler compounds enter, which have it for one of their principles.

3.
We know it only in its compounds.

This ſubſtance, although exiſting ſometimes in a ſolid, ſometimes in a fluid, ſometimes in an æriform ſtate; is never diſtinctly, and abſolutely by itſelf, perceptible to the human

man ſenſes. Such is the exility of its conſtituent partic that, we cannot detach it as yet from thoſe combinatio into which, it has a continual and powerful tendency to e ter, with ſurrounding bodies. We know it only in combinations, and by its effects. Nature never preſents ſolitary; chemiſtry knows not how to inſulate it.

4. Its combination with light and caloric; or Gas-oxygen.

One of the moſt remarkable combinations into which is capable of entering, is that which it forms with *light* a *caloric*. The nature of that myſterious union in which we find *light* and *caloric* uſually joined, has not yet been cle ly aſcertained by the reſearches of chemiſtry. But, it certain, that, in the compoſition of *vital air*, or *oxygen* both theſe ſubſtances are united with oxygen. In the compoſition of oxygen-gas, light and caloric are alw evolved; and oxygen is at the ſame time *precipitated* fr the decompoſed, aeriform compound, into a new com tion. On the other hand, the contact of light and cal in ſufficient quantities, never fails to detach oxygen ou thoſe concrete compounds in which it exiſts, and to fo quantities of gas-oxygen by the proceſs. Theſe facts ford ſufficient chemical demonſtration of the actual ex tence of the ſimple ſubſtance of oxygen, in that aerif fluid which is denominated gas-oxygen; although we nei diſcern its ſeparate exiſtence, nor feel it with our fingers

5. Of the qualities of gas-oxygen.

Gas-oxygen, or *vital air*—as it was once named,—is of the moſt remarkable aeriform fluids in nature. Its culiar character was unknown, till Dr Prieſtley; who w in theſe few years, retired from England to America; ſuing that tract of pneumatical experiments, which had firſt opened by Mayow, Boyle, and Hale; diſcovered the pound nature of atmoſpheric air, and diſtinguiſhed different ſpecies of aerial fluids which are ordinarily

n it. The experiments of Cavendiſh, of Lavoiſier,
d of a number of other eminent chemical philoſophers,
ch and Engliſh, have, ſince, more fully explained the
ities of *gas-oxygen*. This *gas* exiſts in atmoſpheric air
rdinary and mediate purity, in the proportion of 27 or
parts out of 100. It is that part in this compoſition,
eans of which alone, it is fitted for the *reſpiration* of
mals, and for contributing to the phænomenon of *com-*
ion. It is obtained, not only from the atmoſphere, which
erely a grand reſervoir for receiving, preſerving, and
ain affording it ; but from vegetables expoſed to the ſun's
s, from metallic oxyds, from water and all acid ſubſtan-
by the action of light and caloric. Its preſence in too
e a proportion, is unfavourable to the growth of vege-
les. It ſeems, on the contrary, to be required in a very
e proportion, in order to promote the growth, and to
riſh the vitality of animals. It is partly as a vehicle of
ygen liable to be detached out of it, and in part by means
ts other component principles, light and caloric, that it
duces theſe effects. It is by the abſtraction of oxygen
e combined with the light and caloric preſented, that
gen-gas is obtained from vegetables by the action of the
of the ſun.

6.
Of Combustion.

ut, Combustion is the grand phænomenon in which
-gas is decompounded with effects the moſt conſpicu-
and important. Until within theſe laſt twenty years,
miſts ſuppoſed, with all the reſt of the world ; that, in
buſtion, the *flame* beheld, the *heat* felt, proceeded, not
m the air of which the preſence was indiſpenſibly neceſ-
y to this phænomenon ; but from the evolution of a prin-
e which had been contained in the wood, the pit-coal,
peat-earth, or whatever other combuſtible matter was

uſed

uſed as fuel. This principle, ſuppoſed at one lurk unſeen in bodies ſuſceptible of *combuſtion*, at to diſplay itſelf under the forms of light and heat; celebrated *phlogiſton* of STAHL, to which a thouſan myſterious properties were aſcribed. At laſt, ab year 1776, the celebrated M. LAVOISIER of Par lately fell the victim of revolutionary cruelty, diſc that, inſtead of ſuffering, as was naturally to be exp a part of its ſubſtance were actually conſumed in h flame,—any loſs of weight; the matter employed actually gained additional weight by the combuſtion *calces* or *oxyds* of metals were found to be more than the metal ſubjected to calcination. In every in which all the products of the combuſtion coul aſſembled, they were invariably found to exceed in that body from which alone they had hitherto be poſed to proceed. A phænomenon ſo contradictor ideas hitherto entertained concerning the proceſs proper pabulum of combuſtion; could not be accoun otherwiſe than, either by ſuppoſing that the fancied *ton* was a principle of poſitive levity; or by allow ſomething elſe than the apparent fuel, was the properly decompoſed by combuſtion.—The preſ pure air was known to be neceſſary to make com take place. The quantity of pure *oxygen-gas* to ſumed in a particular experiment of combuſti therefore aſcertained with attentive accuracy; as that of the combuſtible *matter* or *fuel* ſubjected combuſtion. The products of the combuſtion we wards weighed. The weight gained to the aſhes products of the combuſtible body, was found to inſtances the ſame, or almoſt the ſame, with that lo the air in which the proceſſes had been conducted. Could it be longer doubted, but a precipitation had taken place, during the combuſtion, out of the air into the burnt body? Of the ſolid body which had undergone the combuſtion, when all the products had been carefully re-aſſembled; it was found that there had been nothing loſt, which might have been regarded as equivalent to the light and heat evolved during the proceſs. What then remained, but to conclude, that theſe alſo were produced not from that *body*, but from the air decompoſed to afford an augmentation of *its* weight?—An experiment of a contrary nature, fully confirmed this idea. Metallic calces, ſince denominated *oxyds*, were univerſally known to be reducible to a perfect metallic ſtate by the application of a red heat, that is, of light and heat together. By this reduction *gas-oxygen* was alſo known to be obtained. And it was now found by accurate experiment; that, by the reduction to the perfect metallic ſtate, the metallic calces loſt a quantity of weight exactly equivalent to that of the *oxygen-gas* obtained during the reduction. Without the application of a red heat, the calces were rarely reducible.—Theſe experiments, and theſe reſults, appeared to prove inconteſtibly, that there was in every proceſs of combuſtion, a decompoſition effected, not ſo properly of the combuſtible body, as of the air ſurrounding it: and that, of the air decompoſed, the *oxygen*, one principle, was precipitated into the burnt body; while the light and caloric, its other principles, were evolved in the forms of heat and flame.—It was already known, that *pure* or *vital air*, alone, was ſuſceptible of contributing effectually to promote combuſtion; and it now appeared, that the moſt remarkable phænomena of combuſtion, aroſe from the decompoſition of that *pure air* which was ſoon to be more accurately denominated *oxygen-gas*.

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CT. III.

7.
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The chemical doctrine concerning combuſtion, is no
therefore wholly changed. Combuſtion, according to i
takes place whenever any ſubſtance ſuſceptible of comb
nation with oxygen, the *baſe* of *oxygen-gas*, is brought in
contact with a quantity of this gas; *while both the combuſti*
body and the gas (independently of the light and caloric exiſti
in combination in the gas) are penetrated and ſurcharged wi
ſuch an exceſs of free caloric, as may give to the caloric combin
in the gas-oxygen, a ſtrong diſpoſition to yield to the firſt attra
tions that offer to detach its oxygen, and to make it evolve itſ
alſo into a free ſtate. The preſence of free caloric in a lar
proportion, or elſe of ſome third ſubſtance, having a powerful te
dency to overcome the attractions of light and caloric for oxygen
is always neceſſary to aid the operation of the attractions betwe
oxygen and the combuſtible body. It ſhould ſeem, that in ord
to produce that evolution of light, without which the blazi
flame cannot appear; there muſt be a ſeparation of light fr
the ſurrounding free caloric, in addition to that which is affor
ed from the decompoſition of the gas-oxygen. During the pr
ceſs, the oxygen diſengaged from the gas, is precipitat
into the burning body; the light and caloric, with the a
ditional quantity of light, here above mentioned, are evol
ed in the form of flame or red heat. Where there is not
ſufficient evolution of light, only heat is perceived. Whe
to aid the attraction between the oxygen and the combu
tible body, ſome third ſubſtance having ſtrong attractions f
caloric, is preſented; the combuſtion may be, in ſome ſe
ſecret, almoſt without any evolution of caloric into a fr
ſtate.

The other combinations of oxygen with different nat
ral ſubſtances ſhall be explained in the farther progreſs
this work.

SECTIO

SECTION FOURTH.

HYDROGEN.

BOOK IV.
SECT. IV.

1. Where HYDROGEN is obtained.

THAT pure freſh water which was long accounted to be, moſt certainly, a ſimple element in nature; has been at length however diſcovered to be a compound ſubſtance; one of the conſtituent principles of which, is a matter which has, from this conſideration of its entering always neceſſarily into the compoſition of *water*, received the characteriſtic and analogical appellation of HYDROGEN. Another ſubſtance, well known to chemiſtry and to natural hiſtory; into the compoſition of which, this *hydrogen* always enters as a principal part; is *inflammable gas*, now rather denominated *gas-hydrogen.*

2. Its qualities in a ſeparate ſtate.

Hydrogen itſelf, which enters always into theſe two notable combinations, and into a multitude of others more complex than theſe; is not a ſubſtance perceptible to our powers of ſenſation, in its ſeparate ſtate. We know it only in its combinations. Its qualities are diſplayed in the changes it produces on the ſubſtances joined in compoſition with it. Its exiſtence is not at all the leſs certain for its being in its ſeparate ſtate, impalpable, and inviſible; or rather, as it ſhould ſeem, incapable of ſubſiſting in an abſolutely ſeparate ſtate. We can purſue it, while it paſſes out of one combination into another. We cannot indeed arreſt it on its paſſage. But, we never fail to diſcover it, at leaſt if we uſe the proper chemical means, when it ſtarts up to our notice in a new compound.

3. Of WATER the moſt remarkable of

WATER, the moſt remarkable of all the compounds in which hydrogen makes any part, conſiſts of hydrogen and oxygen

ts com-
ounds.

oxigen for its two component principles. **In this ex**
nation, the experiments of LAVOISIER, and of **other**
miſts, the diſciples of his ſyſtem, have aſcertained, **that**
drogen exiſts in the proportion of ,86 parts,—**oxyg**
the proportion of ,14 parts. The mutual chemical at
tions between its two principles, upon which the **exiſt**
of this compound depends; are not ſo ſtrong, but
iron, carbon, and oils decompound water, by virtue o
ſtronger attraction which theſe matters have for **hydro**
than it has for oxygen.

4.
roofs of
he com-
ound na-
ure of wa-
er.

Thoſe experiments by which the compound **char**
of water was firſt diſcovered, were of a nature **remark**
curious and ingenious. LAVOISIER, aſſiſted by *De la I*
another French chemiſt of great merit and celebrity;
ſerved, that, inflammable gas, burnt in cloſe veſſels,
the addition of a ſmall quantity of gas-oxygen; **affo**
by the proceſs, ſome drops of pure water; a product w
was not at all expected to reſult from this **combuſ**
M. Monge, another chemiſt, made the ſame **obſerv**
almoſt at the ſame time, but in a different part of **Fr**
and not in concert with LAVOISIER and *De la Place*. T
latter chemiſts repeated the experiment again **and ag**
but ſtill the ſame product was obtained. **It** was **then,**
LAVOISIER ventured to queſtion the elementary **ſimplic**
the character of water; and to ſuſpect it to **be a comp**
of oxygen with a much larger proportion of **another**
ciple, which was to receive the name of *hydrogen*. **Aid**
M. Meuſnier, LAVOISIER ſoon tried new **experiments, i**
der to aſcertain with more certainty, the **truth of a**
general fact of ſuch remarkable importance.—**In one**
uſing a bell-glaſs, filled, for a certain length **from its**
tom, with mercury, and having above the **mercury,**

BOOK IV.
SECT. IV.

out of which the air was wholly excluded by
he mercury; he introduced into this vacant
tain quantity of very pure diſtilled water mixed
of iron. The conſequence was, that the wa-
idually decompoſed by means of the ſuperior
attractions between the oxygen of the water,
. The iron in filings was gradually calcined
. A quantity of inflammmable gas was diſen-
t the whole quantity of the water employed in
ent, was decompoſed; but only ſuch a portion
preciſely ſufficient to afford the inflammable
oxygen conſumed in the oxydation of the iron.
riment of the decompoſition of water ſeemed to
moſt ſatisfactory confirmation of the general
ced from the contrary experiment, in which it
mpoſed out of its two conſtituent principles.—
periment afforded evidence equally convincing,
truth. A gun-barrel was placed in a furnace,
till it became red-hot. Water was then drop-
it. The conſequences were; the oxydation
of the iron of the gun-barrel with a ſuitable
its weight; and the production of a quantity
ble gas, which was received out of the gun-
ell-glaſſes conveniently diſpoſed for this uſe.—
of other analogous experiments have afforded
rmation of the truth of the ſame general fact.
omena from which the votaries of the ancient
ory have endeavoured to draw contradictory
ſeem to have ariſen from the inaccuracy with
e infancy of pneumatic chemiſtry, they have
de their experiments.

WATER,

Hydrogen.

OK IV.
CT. IV.

s
yſical
perties
water.

WATER, this grand compound of hydrogen with ox gen, may deſerve yet a more particular examination in re gard to all its more eminent qualities, phyſical and chemi cal. It is diffuſed over the terraqueous globe, in the ſea in lakes, in rivers, in ſprings. By means of its fluidity, i tends continually into a ſtate in which all the parts o that particular quantity of water which is under examina tion, may remain in equipoiſe with reſpect to one another. Streams deduced from ſprings of water lying in lofty ſitua tions, will aſcend even up a declivity in their courſe, to an height that does not riſe above that of the ſource fro which the ſtream takes its riſe. Water will aſcend fro the depth of a well, to the height of two and thirty fe in any tube out of which the air has been entirely exha ted : A fact which proves the weight of our atmoſph to be every where equal to that of a column of water tw and thirty feet in height. It ſcarcely ever preſents it in nature, otherwiſe than impregnated with ſome or oth of thoſe innumerable matters to which it acts as a ſolve The waters of the ſea are impregnated with muriatic, ma neſian, and other ſalts. Thoſe of ſprings are often im pregnated with iron, and with ſulfuric, magneſian, or ca careous ſalts. Rain-water and the water of ſtreams wh have run far over a bed of clay or ſchiſtus, are uſually t pureſt. Waters which have not run for any conſider length of courſe, and which are impregnated with calc ous ſalts, are found to be unfit for bringing pulſe and ſ other vegetables into that ſoftened ſtate, into which eaſily poſſible to bring them by boiling in water free f the mixture of thoſe ſalts. Boiling and diſtillation rate the calcareous and other ſalts from water. Di water is pure; but being by the diſtillation deprived

it mingles readily, even without chemical
with almoſt any other matter. It is known
nly in a ſtate of *fluidity*, but in a *ſolid*, and in an *elaſ-*
uid ſtate. In that temperature of the ſurrounding at-
phere in which the mercury ſtands at 32° of Fahren-
thermometer, water is ſeen to be congealed into *ice*.
converſion takes place, in the ſeaſon of winter, in all
mperate climates of the globe. Towards the poles,
continues in ice throughout the year. Under the
r, ice is never produced naturally. Water ſtrongly
gnated with ſalts, as in the ſea, requires a more in-
cold to congeal it, than that of 32°. The waters of
prings, and the waters running over a calcareous bed,
ways of a warmer temperature, than that of the air
he common objects around them, in winter. A bot-
water, upon its converſion into ice, burſts the bottle,
ppears to increaſe in bulk. The preſence of the ex-
air contributes to the ready formation of ice. When
n is made to take place very ſlowly, the ice is
clearly diſcernible cryſtals. Ice thus formed, is
le, and lighter than fluid water. Water con-

ſeems to be produced on the other hand by the increaſe the quantity of caloric in a given quantity of water. Fo clouds, miſts, dews, rains, even hail and ſnow, are all pr duced in conſequence of the convertibility of water in vapour. Water is converted into vapour by the preſen of a quantity of free caloric, ſuch as may raiſe the mercu ry in Fahrenheit's thermometer to 212°. This vapour remarkably elaſtic, and under compreſſion, is capable producing terrible exploſions, and of exerting a wonderf force, as is well exemplified in the ſteam-engine.

6. Chemical theory of congelation and evaporation.

As to the other chemical properties of water; it is c rious and intereſting to inveſtigate what preciſe chang take place in the caſes of congelation and evaporation. *Nothing can be more probable than that water, when* CON*GEALED*, *loſes a quantity not only of caloric which was diffuſ through it, without combination, but of caloric that had been ac tually combined with it, and is now detached into combinati with the gazeous ſubſtances in the atmoſphere, and with other matters having ſtronger attractions for caloric than water has.* Again, *when water is evaporated, it ſhould ſeem that a new quantity of caloric is not merely mechanically mixed with the gazeous ſubſtances thus produced, but is attracted into actual combination with it.* Vapour is lighter than common atmoſpheric air; becauſe the proportion of caloric contained in it, is probably greater than that contained in the gaſes which are intermingled in the air of the atmoſphere. But, as the atmoſphere is a vaſt reſervoir of elaſtic fluids, and of almoſt all matters ſuſceptible of ſublimation; the vapours ſuſpended in it, come often into contact with other matters, of which the chemical attractions have power to detach more or leſs of that combined caloric to which alone the vaporous ſtate is owing. Hence all thoſe

hich the moiſture of the atmoſphere is known
upon the earth, from that dew of which the
perceived, till it actually gliſtens upon the plants,
ws, and the hails which deſcend from the air in
n.

en is WATER in its phyſical qualities. And ſuch
material information which chemiſtry furniſhes
that combination of hydrogen with oxygen and
c, by which it is formed; concerning that loſs
ric combined in it, in conſequence of which it is
into ſnow and ice; concerning that exceſſive ad-
aloric, which expands it into vapour.

7.
Beneficial uſes of water.

lies in nature are more beneficial to mankind
. It is the moſt ſalutary of beverages. It ſerves
hanical qualities, as a ſolvent for innumerable ſo-
ces. It affords an excellent medium for the ap-
f heat to ſolid articles of food, for the purpoſe of
heir parts, of ſublimating what is volatile in them,
ſolving that which admits only of ſolution in
water. All diſtillations, with many other che-
ceſſes, are effected by means of it. Converted
, it affords the greateſt power that we can pro-
the moving of pumps, mills, and other engines
uire a vaſt artificial force. Applied alſo in its
id ſtate, to the wheels of mills in a proper maſs,
proper deſcent, it is capable of moving a vaſt
nd a very complex arrangement of machinery.
denſity, that a cubic foot of water weighs 1000
oirdupois: and in conſequence of this circum-
affords a very convenient meaſure, by reference
we can eſtimate the ſpecific gravities of all other
its terms of freezing and of ebullition, afford the
moſt

ermometer. The p
indicates the deg
acity of water for c

important compoun
principal element. In t
ot, as in water, with o
This compound is abundan
from the decompoſition of
and is deprived of its oxyge
may have a ſtronger attracti
hydrogen; inflammable or
ated in large quantities, over
water. In particular ſtates of
caloric, being in it in a ver
engaged; and ſudden blazes of fla
So great is the proportion
exiſts in gas-hydrogen, in comb
that a cubic foot of this gas wei
grains. Gas-hydrogen uſually carri
either ſuſpenſion or ſolution, a pro
derable, of the ſubſtance with wh
combined. Sometimes it is mix
carbonic-acid-gas, or with vital a
as we find it holding in ſolution, wat
phoſphorus, arſenic, oils, alcohol, æth
ces of a ſimilar character. This circu
is what gives riſe to the diverſity of t
hydrogen, and procures to it that variety of
which it is known. Another quality in the
this gas, which it derives from its poſſeſſing
large a proportion, is, that, all compound matt

claps of thunder, are nothing elſe but acts of
of gas-hydrogen with gas-oxygen; both
being diffuſed in very great abundance in the
gions of the atmoſphere: and that the rain which
opiouſly at the times when theſe combuſtions take
produced by the union of hydrogen from the one
oxygen from the other. All animal or vegetable
s—except charcoal; which are ſuſceptible of com-
n the open air; will afford gas-hydrogen, if heat-
s veſſels. The pureſt of all inflammable air, is
h is evolved from acids in which certain metallic
s are diſſolved. In a ſtate of high purity, this gas
es as light as common air. Nay it has even been
in a ſtate, in which its levity was ſeventeen times
tmoſpheric air. The well known air-balloon is
y filling any hollow globe, with a covering ſuffi-
ſe and light, with a quantity of gas-hydrogen.
ition proceſs for obtaining inflammable air for the
miſtry; is, by the diſſolution of filings or ſhav-
in diluted ſulphuric acid.

e, or the volatile alkali, another compound in-
ogen enters, will come to be conſidered more

:MENTS OF CHEMISTRY.

BOOK FIFTH.

LE SUBSTANCES WHICH ARE SUSCEPTIBLE OF BEING CHARACTERIZED AS ACIDIFIABLE BASES.

SECTION FIRST.

E, NITROGEN, OR ALKALIGEN: AND OF ITS COM-
NS WITH SIMPLE SUBSTANCES ALREADY DESCRIB-

I. Whence Azote is obtained.

me frequently trodden by cattle, and impregnated
ir excrements; the walls of old houſes; dry ditches
th animal excrements, old mortar, and the remains
ables; almoſt all places containing animal matters
: of putrefaction; cheſnuts particularly as a fruit;
ls capable of fermentation: Afford a ſubſtance, in
priſmatic cryſtals, terminating in dihedral pyramids,
the ends with a ſlope, and often channelled from
to the other; which is known by the name of NI-
ALTPETRE; and is ſuſceptible of farther decompo-
n. This ſubſtance is alſo ſometimes to be found
f chalk. From chalk of Roche-guyon in France,
Duke de la Rochefoucault obtained ſuch *nitre*, in
rtion of an ounce out of the pound.

This

BOOK V.
SECT. I.

This ſubſtance, ſubjected to certain chemical proc
decompoſed into two different bodies. Of theſe,
is a white, yellow, or red liquid, known by the
either *nitric* or *nitrous* acid. Renewed decompoſit
ercifed upon this liquid, reſolves it into two parts,
and a new and peculiar ſubſtance, which has acqui
name of AZOTE, *nitrogen*, or *alkaligen*.

2.
Decompoſitions affording it.

This ſubſtance, obtained from thoſe materials,
theſe ſucceſſive decompoſitions, is a ſimple, element
In an inſulated and peculiar ſtate, it is not diſtinc
ceptible to the human ſenſes, however aided by inſtr
We know it, only in its combinations. But, the re
its exiſtence is unqueſtionable; ſince we can mark
ſage out of one combination into another; ſince w
the laws of chemical attraction to which it is ſubje
we diſcern the preciſe character of thoſe ſimple ſu
with which it is combinable, and can diſtinguiſh th
of the new compound which the combination p
PRIESTLEY, *Cavendiſh*, LAVOISIER are the chemical
phers to whoſe reſearches we owe the diſcovery of
iſtence of this ſubſtance of *azote*. PRIESTLEY's diſ
ſuggeſted to LAVOISIER a theory, which the exp
of *Cavendiſh* finally illuſtrated and confirmed.

3.
Its nature as a ſimple ſubſtance.

One of the moſt remarkable combinations int
this ſubſtance is known to enter, is, that which tak
between it and *light* and heat or *caloric*. The co
thus produced, is named GAS AZOTE, which has b
called *phlogiſticated air*, or *atmoſpheric mephitis*. Of th
pound, there exiſts always in the atmoſphere, a pro
equal to no leſs than 72 parts out of 100. It may
tained out of any atmoſpheric air, by any proceſs ad
effect the abſorption of the *gas-oxygen* and the *carb*

4.
Its combination with caloric in GAS-AZOTE.

h are united with it in that mixture. It may be from any fibrous or muſcular animal ſubſtance, a freſh ſtate, and ſubjected to the application of id. It is this gas-azote which fills the air-bladder arp; as has been diſcovered by Dr Priestley and ourcroy; and may be at any time aſcertained anew, ing that air-bladder under an inverted glaſs filled ter. *Gas-azote* is lighter than atmoſpheric air; in- extinguiſhes burning tapers; acts with great energy pidity in deſtroying the life of animals which are im- it. Mixed with *gas-oxygen* in the proportion of 27, it will afford a factitious atmoſpheric air. Mixed s-oxygen in the proportion of 3 parts to 7; and poſed to the action of the electric ſpark; it ſuffers nſation, in conſequence of which nitric acid is pro- rom the gas-azote and the gas-oxygen. From all matters ſubjected to the action of fire, or to putre- there is obtained a large proportion of gas-azote— evolution, no doubt, of the *azote* into combination loric which the atmoſphere is ever ready to furniſh. e ſtates of the atmoſphere, in which the proportion caloric diffuſed through it, is uncommonly ſmall; ion, and by conſequence the evolution of gas-azote e putrefying matters, is known to be particularly *Gas-azote* is diſtinguiſhable from carbonic-acid-gas, much lighter than this gas; and as not being fit- e it, to redden tincture of turnſole or precipitate er.

4. Nitrous Gas.

more remarkable are thoſe compounds which are d by the combination of *azote* with *oxygen* as well caloric and *light*. Nitrous gas is an elaſtic fluid nded of *azote* and *oxygen* in combination with *calo-*

OOK V.
SECT I.

ric. Its exiſtence appears to have been partially a perfectly known to the celebrated Dr *Stephen Hale* fully and accurately aſcertained to exiſt as a peculiar g ſubſtance, by Dr PRIESTLEY. It is obtained from nitr by the action of metals, oils, mucilages, alcohol, and combuſtible ſubſtances. It extinguiſhes lights; de animal life; is incapable of alteration by the preſen pure water. It admits of many varieties in the propo of the component principles. It contains oxygen in ger proportion than that in which this ſubſtance ex common atmoſpheric air. It is not heavier than co atmoſpheric air. Retaining ſtill a ſtrong attraction c petency for oxygen; it enters eagerly into combinatio additional quantities of this ſubſtance, and by the con tion, forms *nitrous* or *nitric acid.* The formation of ni cid by *nitrous gas* attracting oxygen from atmoſpheric a been aſſumed by Dr PRIESTLEY, to afford a teſt of the cular degree of the vital purity of any quantity of air the atmoſphere. Take a ſmall portion of the atmoſ air, of which you deſire to bring the purity to th Confine it in a phial above water or mercury. Into thi tion of air thus confined, then introduce a portion o rous gas. If the atmoſpheric air under trial, be very and contain much oxygen; a proportionately large q ty of nitric acid will be formed. If, on the other there be little oxygen in the atmoſpheric air, and conſiderably impure; but little nitric acid will be p ced, or perhaps the new product will not have th ſtrength of nitric acid.

5.
TROUS
D.

A third compound of *azote* is, NITROUS ACID.

Thoſe ſubſtances which chemiſts diſtinguiſh by th neral name of ACIDS, have, in common, the qualities *ſourish* taſte,—a tendency to communicate a *red co-* vegetable ſubſtances ſubjected to their action,—a *to combine* with earths, alkalis, and metallic —a *compound formation* into which oxygen always for one principle. The NITROUS ACID differs from *gas*, chiefly in containing in its compoſition, a larger tion of oxygen than exiſts in the *gas*. This acid is *red* in its colour; and appears to emit dark red in greater or leſs abundance, according to the tem- which it is expoſed. If diſtilled in a retort of part goes off in vapours; and what remains, colourleſs nitric acid. In its other properties, it materially, otherwiſe than in being weaker, from acid. The red vapours take properly the appel- *nitrous-acid-gas*.

6. NITRIC ACID.

NITRIC ACID is white, liquid, not volatile; poſſeſſes ong cauſticity, as inſtantaneouſly to burn and deſ- organization of the animal muſcle; reddens ſyrup s, with the entire deſtruction of its primary colour. tion of the rays of the ſun, gives it a higher colour ater volatility. *Caloric* otherwiſe applied, volatilizes ſeparates the colouring matter in the form of red —The red and *nitrous* acid unites eagerly with wa- compound takes a green or blue colour: It ap- have acquired new heat, while this combination ce: With a large quantity of water, the acid forms called *aquafortis*. This *aquafortis* is the form in the acid of nitre is moſt commonly applied to the the arts. In this form, it is uſed to diſſolve mercu- per, ſilver for hatters, engravers, and gilders, in aſ- and working metals, &c. It is uſed alſo in ſurgery, warts, and other indolent, uninflamed tumors.

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It is uſed, too, in many pharmaceutical preparations. *nitric acid* was by the experiments of *Cavendiſh*, aſcerta to be a compound of *ſeven* parts of gas-oxygen with parts of gas-azote, and with a certain proportion of and *caloric.*

7. Ammoniac.

Another of the componnds of *azote*, is, AMMOI or *volatile alkali*, which has been recently diſcov to be a compound of *hydrogen* and *azote*, but was ſuppoſed a ſimple ſubſtance. But, deviating from order which rigorous analogy ſeems to require; tha may not too widely depart from eſtabliſhed cuſtom; ſhall rather defer the explanation of the nature of MONIAC, till we come to conſider alſo thoſe other ſubſta which poſſeſs with it, the common name of alkalis.

SE

SECTION SECOND.

, AND ITS COMPOUNDS BY UNION WITH THE SIM- E SUBSTANCES PREVIOUSLY DESCRIBED.

1. CARBON,—whence obtained.

nd all other vegetable metals, if expoſed to a : in veſſels which are partly cloſe; ſuffer a partial ; by which their volatile parts are driven off, and combuſtible matters belonging to them, are ac- mpoſed; but by which very little of their princi- tible component part is conſumed. This com- nponent part is known in modern chemiſtry by f CARBON. That matter which is, in the arts, mon life, familiarly known by the appellation of ; is not abſolutely pure *carbon*; but carbon con- nd mixed with various other vegetable and em- products.

2. Its form and properties.

RBON; the principal pure reſidue of wood, of organic contexture has been deſtroyed, and the ile parts diſpelled by fire; is a ſimple and hither- npounded ſubſtance. Even in charcoal, it ap- iſt in combination with a ſmall portion of earth, of ſoda or potaſh, and occaſionally with various It preſents itſelf to our ſenſes, as a black, fri- ſt gliſtering ſubſtance. It is very extenſively roughout nature. In all vegetables it forms a art. In foſſils originating from the decay of ve- is found alſo to exiſt. Nor are animal matters . It enters likewiſe into minerals. The putrefac- nal and vegetable ſubſtances, is always found to on. As it forms a principal reſiduum of vege-

tables;

tables; ſo is it alſo one of thoſe ſimple ſubſtances by the abſorption of which, in one form or another, their growth is chiefly promoted, and their vegetation maintained. In the pureſt ſtate in which we can uſually obtain it; *carbon* is believed to be always mixed with ſome ſmall portion of oxygen,—to the preſence of which Dr Bancroft has been induced to aſcribe its black colour; and with a very ſcanty proportion of water,—which, when the carbon is expoſed in cloſe veſſels to an intenſe heat, will often be found to yield ſome ſmall portion of gas-hydrogen. Expoſed to the action of caloric without the preſence of air or any other ſubſtance, pure carbon is not liable to ſuffer any change. In its various combinations, it acts a diſtinguiſhed and very important part.

3. he CARBONIC ACID.

In its principal combination, it forms that acid which is known by the name of *Carbonic-acid-gas* or ſimply CARBONIC ACID. Expoſe pure carbon to the action of caloric, in an atmoſphere of gas-oxygen, or of atmoſpheric air of ordinary purity, a combuſtion will enſue at the proper temperature; while the caloric and light eſcape, for the moſt part, out of their combination with the oxygen, into a free uncombined ſtate: The oxygen *precipitated* out of the decompoſing gas-oxygen, will unite with the carbon: And, the product of this union, will be *carbonic acid*. In the atmoſphere in its ordinary ſtate, this gazeous acid exiſts, according to the experiments and inductions of LAVOISIER, in the proportion of 1 part out of 100. It is evolved from animal and vegetable matters by many natural proceſſes. It is formed alſo in caves and pits. It is a product of ſpirituous fermentation. It is a product of reſpiration. It is found in many minerals. It is conſtantly exhaled from the leaves and other parts of plants, in the ſhade.

Whether

Whether collected from nature, already formed,—or produced by the artificial combination of oxygen with carbon; it ſtill ſhews itſelf in a gazeous form, and exerts all the energies of an acid. It is, like air, inviſible and elaſtic. Its ſpecific gravity is twice that of common air. It may be poured out of one veſſel into another: it flows from the top of a wine-caſk, after the wine is drawn off. Its taſte is pungent and ſubacid. It is noxious to animals; and therefore cannot ſerve for the purpoſes of reſpiration. It extinguiſhes lights, and ſuffocates all combuſtion. Its energy as an acid, being but feeble, although diſtinct and certain; it is unable to effect any deciſive alteration on the colour of ſyrup of violets. Neither light nor caloric ſeems to operate any diſtinct effect upon it; farther than that, by the action of the latter, it is ſubject to be dilated. It mixes, without combining, with gas-oxygen.

4. Combination or mixture of the *carbonic acid* with *water*.

With *water*, *carbonic acid* unites—but ſlowly. Theſe two fluids, after conſiderable agitation together, at laſt combine to form an acidulous liquor. The colder water is, ſo much the more of carbonic acid, will it diſſolve and abſorb. But, there is a point of ſaturation, beyond which this combination cannot be urged. Even the coldeſt water will not diſſolve more than a quantity equal to itſelf in bulk. Water ſaturated with carbonic acid, is ſomewhat heavier than pure diſtilled water. It ſparkles upon agitation; has a pungent, acidulous taſte; reddens the tincture of turnſole; is decompoſable by heat which quickly brings it to ebullition, and diſengages the elaſtic fluid; a diſengagement which is ſtill more rapidly effected by the free contact of air. Nature preſents it in the acidulous, mineral waters of Pyrmont, Seltzer, &c. The great LAVOISIER firſt diſcovered carbonic-acid-gas to be a compound of oxy-

gen

BOOK V. SECT. II.

gen with carbon,—by ſome experiments in which o
formed this gas by combining its two principles,
others which tended fully to aſcertain the accura
laſt. The reſults of his experiments repreſented
gas, as conſiſting of 26 parts of carbon in unio
parts of oxygen. Others have alledged this c
to be in the proportion of 12,0288 parts of
56,687 of oxygen. The proportion of the ſpeci
of *carbonic acid* to that of common air, is acc
Kirwan, as 68,74 to 45,69: LAVOISIER makes i
48,81. This acid is in various caſes, like other
compoſed and reſolved into its principles. Wat
ed with it, is much fitter than diſtilled or comm
for the production of vital air, on the leaves of
expoſed to the ſun's rays.

5. Decompoſition of *carbon.*

Some ingenious experiments have ſeemed to
that *carbon* was a compound conſiſting of hydrog
with azote. But, this reſult has not been, as ye
ed by ſuch a train of agreeing experiments, as mi
us in adopting it for a chemical truth.

SECTION THIRD.

OF SULPHUR, AND THE SIMPLEST OF ITS COMPOUNDS.

BOOK V. SECT. III.

1. Whence SULPHUR is obtained.

THE mineral kingdom of nature furniſhes in great abundance, a dry combuſtible ſubſtance known by the name of SULPHUR. It is of an opake, citron-yellow colour; without ſmell, except when burnt; very brittle; of a peculiar, faint taſte; ſubject to become electric upon being rubbed; when expoſed to a moderate but ſudden heat, liable to crackle and break into pieces. It is found in nature, ſometimes perfectly pure, but oftener in combination with various other ſubſtances. FOURCROY has enumerated ſeven different varieties of form in which pure ſulphur is found in nature. It is uſually either in tranſparent octohædral cryſtals, in irregular fragments alſo tranſparent, in a pulverulent, or in a ſtalactitical form. It is obtained alſo from animal matters, both in a cryſtalline and in a pulverulent ſtate. It is furniſhed, in the greateſt abundance, by thoſe compound ſtony bodies, which are well known in the mineral kingdom, by the name of *Pyrites*.

2. Extraction of ſulphur from Pyrites.

From *pyrites*, SULPHUR is extracted by the following proceſs. Broken into ſmall pieces, and put into earthen tubes; the pyrites are thus expoſed to the heat of a furnace. A ſquare veſſel of caſt-iron, and containing water; is connected, as a receiver, with the tube in the furnace. The action of the fire, proceeds; and the ſulphur being thus melted, is gradually accumulated, on the water in the receiver. Removed from this receiver; it is then melted in an iron ladle; in conſequence of which, the earthy and metallic parts, with which it was contaminated; are *precipitated*, or ſubſide

ſubſide to the bottom of the ladle; leaving the purified ſulphur above. Being next poured into a copper-boiler; it is here purified by farther fuſion; and depoſites other extraneous matters. Having remained here in fuſion, for ſome time; it is then at laſt poured into cylindrical wooden moulds; and in theſe takes the form in which we uſually ſee it in commerce. At Rammelſberg, the ſulphur of maſſes of pyrites, roaſted in the open air, is taken off in ladles; and is purified by a ſubſequent fuſion.

3. Sulphur is a ſimple ſubſtance.

The SULPHUR, thus preſented pure by nature, or obtained by the decompoſition of mixed natural bodies; is, for as much as chemical philoſophy has hitherto been able to diſcover, a perfectly ſimple and elementary ſubſtance. Its qualities in this character, are to be particularly examined.

4. Action of light and caloric on ſulphur.

From the action of *light*, it appears to ſuffer no alteration whatever. When it is, in cloſe veſſels, ſubjected to the reaction of free heat or *caloric*; it becomes ſoft, and melts. When afterwards cooled, it generally aſſumes a needled form, and a red, brown, or greeniſh colour. Rouelle, in order to cryſtallize it by this proceſs; ſuffered the ſurface of the melted ſulphur to congeal; and then poured off the fluid beneath. The under ſurface of the cruſt, now exhibited itſelf in needles croſſing one another in various directions. *Sublimation* is the laſt proceſs with heat, which art employs to give to ſulphur that perfect purity, in which it may be adminiſtered in medicine.

5. Action of water on ſulphur.

Water has no immediate action on ſulphur. Yet, by long contact, water at length ſoftens the outſide of a maſs of ſulphur. Sulphur; heated, nearly till it be about to kindle into flame; then poured into water; becomes ſoft and tranſparent.

BOOK V. SECT. III.

when expoſed, at a proper temperature, to the ac- gas-oxygen, that ſulphur exhibits ſome of its moſt re- ble appearances, and enters into the moſt conſider- all its combinations. Dr PRIESTLY obſerved, that am of water, paſſed over ſulphur, in a heated earthen afforded an evolution of gas-hydrogen. The new nation of pneumatic chemiſtry, explains to us; that nomenon was occaſioned—by the attractions between ygen and the ſulphur, accompliſhing a new combina- which left the hydrogen of the water at liberty to en- to union with its proper proportion of light and ca-

6. Action of oxygen on ſulphur.

It had been before obſerved by Hale; that ſulphur ent to abſorb, while burning, a very large proportion LAVOISIER, making ſulphur a particular ſubject of and ſyſtematic chemical inveſtigations; aſcertain- at, it burns not, without the preſence of gas-oxygen; uring its combuſtion, it abſorbs the pureſt part of the rounding it; that, the reſidue of atmoſpheric air in ſulphur has been burnt, is no longer fit to maintain ſtion; that, of conſequence, ſulphur, during its com- n, abſorbs the oxygen out of the air, whether atmoſ- c or purely vital, in which it burns. All the experi- s of other chemiſts, whether made with a view to re- r to confirm LAVOISIER's theory, have agreed in ex- g clearly theſe ſame reſults, in reſpect to the combuſ- f ſulphur.

Production of SULPHURIC ACID.

e new compound formed by this union of ſulphur oxygen, is the SULPHURIC ACID. But, of this acid are two varieties, of which one only is properly de- nated the *Sulphuric Acid*; while the other is named LPHUREOUS ACID. A rapid combuſtion of ſulphur, with reſence of gas-oxygen, produces the *ſulphuric acid*,

7. Different ſtates of ſulphuric acid.

containing

OOK V.
CT. III.

containing a large proportion of oxygen: A ſlow and cult combuſtion, attracting but a ſmaller proportion of gen into combination with the ſulphur, produces only *ſulphureous acid.* Theſe acids are ſuſceptible of being duced by an intenſe heat into a gazeous form, in w they compoſe *ſulphureous-acid-gas*; which is liable to b gain condenſed into liquidity, by the proper applicatio cold. Beſide being thus produced by the direct com tion of ſulphur; the *ſulphuric acid* and its weaker varie have been alſo obtained by the combuſtion of the nat compound known by the name of *Martial Vitrol.* acid has been alſo found, in a diſengaged natural ſtate ſome parts of Italy. Baldaſſari obſerved it in this ſtate, grotto in Tuſcany, at St Albino, and at the lakes of vale. Vandelli relates, that ſulphuric acid is ſomet found diſſolved in water, in the environs of Sienna and terbo. M. Dolomieu is ſaid to have found it in pure tals, in a grotto on Mount Etna.

8.
form and
mbina-
ns.

The ſtrong *ſulphuric acid* appears, when pure, unde form of a very tranſparent oleaginous fluid; is twice ſpecific weight of diſtilled water; and is always in u with water, from which art knows not yet, how to ſep it, entirely. Concentrated, it burns and cauterizes ſkin; and reddens ſyrup of violets, without deſtroyin colour. If diluted in a large proportion of water, it ſour, ſtiptic taſte. Highly concentrated, it forms wha been inaccurately termed *Oil of Vitriol.* It may be ma aſſume a concrete form, either by expoſing it to cold, combining it with various elaſtic fluids. It has been in affirmed, but not with ſatisfactory proofs, that ſulp acid long expoſed, in cloſe veſſels, to the *rays of the* gradually aſſumes a colour, and even affords ſulphur.

bab

are againſt this. Expoſed in a retort to the ſtrong fire or *caloric*, it loſes part of its water, and its lour. The proceſs by which this is effected, is centration and *Rectification* of the acid. It is dur- roceſs, that the vapours named *ſulphureous-acid-gas*, aged. By carrying this proceſs farther, we diſ- at the *ſulphuric acid* is ſuſceptible of ſtill higher The acid diſtilled to dryneſs, leaves in the receiv- a reſidue, which is found to conſiſt of ſome ſalts in ſolution in the acid. This pure con- *phuric acid* attracts moiſture, and loſes ſome aſticity, when it is expoſed to the open air; coloured by the contamination of combuſtible rom the atmoſphere; and is found upon particu- nation to abſorb from the atmoſphere alſo twice eight of water. By a ſeries of curious experi- rformed during the violent cold in the month of 1776; the Duke D'Ayen reduced the concentrated acid into a ſtate of congelation, at the cold tem- of from 6° 15′ to 65° 45′. Uniting with *water*, uric acid diſplays all the phænomena of a ſudden n and an intimate combination. A hiſſing noiſe, of the extruſion of air from the water; and a etid odour; attend this union. Sulphuric acid large quantities of *carbonic acid-gas*. *Nitric acid* pon ſulphuric-acid which is coloured by the pre- ſome combuſtible body, deſtroys the colour, and he tranſparency of the whole mixture. The mix- fterwards heated, affords an exhalation of nitrous is eaſy to ſee that this phænomenon takes place, portion of the nitric acid is partially decompoſed; oxygen to ſaturate the impure ſulphuric acid, and,

as

as it were, to burn the combuſtible matters contai it. *Nitrous gas* united with ſulphuric acid, make ſume a concrete form.

9. SULPHUREOUS ACID: The SULPHUREOUS ACID is a ſomewhat different m tion of the combination of ſulphur with oxygen. T tral ſalts,—or *ſalts formed by the combination of an acid* *earth or alkali*,—which it affords; are all, in their na configuration, different from thoſe which the ſulphu forms with the ſame ſubſtances. It may be conſide a ſort of intermediate body between ſulphur and ſul acid. **SULPHUREOUS ACID GAS.** SULPHUREOUS-ACID-GAS is to be regarded merel phureous acid in a gazeous ſtate. It is ſomewhat more p ous than common air. It extinguiſhes lights, kills a reddens and diſcolours ſyrup of violets. Charcoal, bodies which are conſiderably porous, will abſorb t M. Monge, by the application of an intenſe heat, ſu ed ſo far as to condenſe this gas, although formerly t to be permanently gazeous. This acid gas is procure ſulphuric acid, by heating this laſt ſubſtance; in its c trated ſtate; with mercury, in a glaſs retort; and receivi product into an inverted bell-glaſs filled with the metalli and ſtanding in a baſon of the ſame. The mercury in tort, attracts away ſome part of the oxygen from the c trated ſulphuric acid. That which ſtill remains in t is ſufficient—only to give it the character of *ſulph* *acid-gas*. The acid-gas is capable of a very intimate with its kindred acid. Sulphureous-acid-gas in unio ſulphuric acid, appears from the reſearches of Fou communicated to the French Academy of Sciences year 1785; to occaſion the concretion of the latter, *black ſulphuric acid of Northauſen*; which is liable to by fuming, a concrete ſalt. The fuming concrete a

ob

BOOK V. SECT. III.

obtained from the ſalt of Northaauſen, is a ſaturated combination of ſulphuric acid with *ſulphureous-acid-gas.*

Uſes of theſe acids in the arts.

All theſe three combinations—of oxygen with ſulphur in more or leſs of light and caloric, are of uſe for different purpoſes in the arts. The *ſulphuric* acid is one of the moſt [illegible] menſtrua in the laboratory. In medicine, it is, [illegible] applied, a very uſeful cauſtic: taken internally [illegible] large dilution in water, it is a refreſhing, cooling, and [illegible] remedy. The *ſulphureous* acid, whether liquid [illegible], is uſed, in dyeing, for whitening ſilks, taking [illegible] &c. The *ſulphuric* acid is uſed alſo by the dyer [illegible] hatter, &c.

10. Combination of ſulphur with gas hydrogen; or SULPHURATED HYDROGENOUS GAS.

[illegible] is ſuſceptible of combination, not only with [illegible], but alſo with HYDROGEN, or rather with the compound which this laſt ſubſtance forms with light and caloric. The new combination thus produced, is SULPHURATED [illegible]OUS GAS. It has an inſufferably fœtid ſmell, is in[illegible] fatal to animals, communicates a green colour to [illegible] of violets, and burns with a light-blue flame. Kind[illegible] burn in a large bell-glaſs, over mercury; it affords [illegible], and a depoſite of ſulphur; products which ſuffici[illegible] indicate the compoſition of the original matter. Oxy[illegible] decompoſes it, and occaſions a depoſition of the ſulphur. [illegible] therefore ſeem, that *gas-hydrogen* completely ſa[illegible] with oxygen, cannot combine with ſulphur; and that [illegible]ractions between oxygen and hydrogen are always [illegible] powerful than thoſe between hydrogen and ſulphur. [illegible] waters, which are mineralized by this *ſulphurated [illegible] gas*; are well known to loſe a part of their mi[illegible], whenever they are brought into contact with the [illegible]ſphere. *Sulphurated hydrogeneous gas* was artificially [illegible]ied by M. Gengembre, by melting ſulphur above mercury

mercury, in a bell-glaſs filled with hydrogenous-gas, unde expoſure to the heat of the ſun's rays. The nature of thi compound will be farther illuſtrated, when we ſhall com to ſpeak of the alkaline neutral ſalts. *Water* diſſolves *ſul phurated hydrogenous gas* with ſufficient readineſs; and a per fect imitation of ſulphurated mineral waters, is produced b the ſolution. *Sulphureous acid* detaches the gas-hydrog from the ſulphur. The *red, fuming nitrous acid* likew *precipitates* the ſulphur of ſulphurated hydrogenous gas; an in the phænomenon, acts with great energy.

11. Reaction between ſulphur and the *nitrous* acid.

There is alſo a reaction between SULPHUR, and the *fu ing red nitrous acid.* This acid poured on melted ſulph occaſions detonation and flame. Sulphuric acid is produ ed by this event; and there is a diſengagement of *gas-*

Such are,—the character of SULPHUR,—the reacti which take place between it and various ſimple ſubſtanc —and the compounds which it forms with *oxygen*, and wi *gas-hydrogen*. Its other compounds will be explained, we advance.

SECTIO

SECTION FOURTH.

OF PHOSPHORE AND ITS SIMPLER COMPOUNDS.

HOSPHORE or *phoſphorus* is a ſubſtance conſiderably plenti- in the kingdoms of nature, although not eaſily to be obtain- in a ſtate of perfect purity. In its ordinary purity, it is t unlike to ſulphur, in colour and conſiſtency. It is, wever, more inflammable than ſulphur, and leſs brittle. hen very pure, it is of a clear, tranſparent, yellow colour. is cryſtallized, lamellated, and fuſible. In nature, it is ver found pure. But, there are ſaid to be in Spain ole mountains compoſed of phoſphoric acid in union h lime. It is often found, too, in union with lead or iron. Its exiſtence was firſt diſcovered in the year 1667, chemiſt of the name of *Brandt*, a citizen of Hamgh. After Brandt had made known this ſubſtance, but ncealed the means by which he made the diſcovery; curioſity of chemiſts in general, was highly excited; d they were all deſirous to produce phoſphorus, as ll as Brandt. *Kunckel*, after many unſucceſsful eximents, at laſt obtained it from urine. In the year , *Boyle*, not leſs ſucceſsful, preſented a ſmall quanof phoſphorus to the *Royal Society of London*. *Boyle* wards communicated his proceſs to *Godfreid Hankts*, a German who had an excellent laboratory in Lon. It was by this man prepared for general ſale, in ſequence of which it ſoon became known throughout ope. Yet, the preparation was long a ſecret. In the r 1737, a foreigner made offer at Paris, to communicate

1.
PHOSPHOR
how obtained.

OOK V.
ECT. IV.

an infallible ſecret for preparing it. The French acad
of ſciences appointed four of their number to make tri
the boaſted ſecret. It ſucceeded. The foreigner was rew
by the French government for his communication. H
gave an account of the proceſs, in a memoir inſerted in
the memoirs of the academy for the year 1737. This
ceſs was, however, extremely tedious; and was there
ſcarcely repeated by any chemiſts, ſave by the elder R
in ſeveral courſes of his chemical lectures. In the
1743, Margraaf publiſhed, in the memoirs of the aca
of Berlin, an account of a much ſimpler proceſs for o
ing phoſphorus. This proceſs has been farther ſimpl
It now appears, in general, that *urine*, *bones*, and ſ
other parts of *animal bodies*, afford phoſphorus: and
the reduction of theſe matters, if ſolid, into a ſtate of
cient comminution; and the ſeparation of thoſe variou
with which the phoſphorus is intermixed,—by mean
diſtillation, ſublimation, ſolution; will, under the la
chemical attraction, at laſt yield phoſphorus or PHOSP
in a ſtate of conſiderable purity.

2.
s aſpect
nd phyſical
ualities.

Thus obtained, and refined to its utmoſt purity, *Ph*
cryſtallizes by cooling, into brilliant plates or laminæ
micaceous appearance. In hot water, it melts, a conſi
ble time before the fluid be heated to ebullition.
highly volatile; and when acted upon by a moderate
riſes in a thick vapour. In contact with air, it exh
thick ſmoke from every part of its ſurface. This w
exhales a ſtrong ſmell of garlick; and appears white i
light,—in the dark, very luminous. The effuſion of th
minous vapour, is, in truth, a ſlow combuſtion of the
phorus from which it proceeds. And this phænomenon
takes place, unleſs when the phoſphorus is in contact w

PHOSP

3.
Reaction of light and heat on phoſphor.

PHOSPHORE expoſed, without acceſs of air, to the contact of *light* and *heat*, is not known to ſuffer from them any material change.

4.
Combuſtion of phoſphor; and formation of phoſphoric acid.

Oxygen is the grand agent by whoſe influence it is liable to undergo a change of ſtate. Such is its appetency for oxygen; that, in conditions, and at temperatures apparently the moſt unfavourable, if there be but at all the acceſs of atmoſpheric air; phoſphorus never fails to attract at leaſt enough of oxygen, to bring it into that ſlow combuſtion by which the *phoſphorous acid* is formed. This ſlow combuſtion will eaſily take place at the temperature of between 66° and 67° of Fahrenheit's thermometer, or even at a lower temperature. At the temperature of 86°. of Fahrenheit, it kindles with decrepitation; burns with a lively white flame, mixed with appearances of a yellow and green colour; and deſtroys with great activity, any combuſtible body coming within its reach. The *phoſphoric acid* is the product of this combuſtion. The beautiful experiments of LAVOISIER upon the combuſtion of this body, have ſhewn; that no more than a given quantity of phoſphore can be burnt in a given quantity of air; that, the proportions amount to 1 grain of phoſphorus to 16 or 18 cubic inches of air; that after this combuſtion, the phoſphorus is extinguiſhed; and the air rendered unfit to ſupport a new combuſtion; that the bulk of the air is by the combuſtion diminiſhed, and the phoſphorus converted into white ſnowy flakes which fix on the ſides of the glaſs veſſel in which the experiment is performed; that the weight of theſe flakes, is preciſely equal to—that of the original phoſphorus —together with the diminution of weight which the air has ſuffered by the combuſtion. Theſe reſults evince clearly, that the combuſtion of phoſphorus, is, like other inſtances

of

of combuſtion, accompliſhed by the combination of the phorus burnt—with oxygen. The explanation of this nomenon, formerly given by chemiſts, was far diff The production of *phoſphoric acid* by the combu phoſphorus may be accompliſhed,—either by burning the rapid way, under a bell-glaſs filled with atmoſ air, and immerſed in mercury; or by paſſing a ſtrea vital air through phoſphorus melted under water; burning it with weak nitric acid; or by that ſlow bu which has been improperly termed the formation of phoric acid *per deliquium*, and which conſiſts merely poſing ſticks of phoſphorus, in a proper poſition, acceſs of atmoſpheric air.

5. rm and alities of oſphoric d.

Pure *phoſphoric acid*, obtained by any of the three ner of theſe proceſſes, is in the form of white flakes, f light, deliqueſcent, and of a very ſtrong acid taſte. poſed to *air*, it quickly attracts moiſture. Brought contact with water, it eaſily melts; affording a white without ſmell, of an oily conſiſtency, very ponderous, ſtrong acid taſte, and capable of changing blue veg colours into red Expoſed, in a retort, to the action o it affords a pure phlegm; the remaining acid is co trated, even to a more ponderous ſtate than that of th centrated ſulphuric acid: By degrees, it acquires conſ cy and opacity; and appears like a ſoft extract: If u at laſt, by a violent heat; it melts into a tranſparent which is hard, highly electric, and inſoluble. *Phoſphori* obtained by the proceſſes above deſcribed, and concent if diſtilled in its dry ſtate with carbone,—will afford phorus; for the oxygen of the acid is attracted into nation with the carbon. *Crell* having concentrated phoric acid to dryneſs, found its ſpecific gravity to be to that of water as 3000 to 1000.

6.
The phosphorous acid.

The PHOSPHOROUS ACID, the reſult of the ſlow combuſtion of phoſphorus, bears to the *phoſphoric acid*, nearly the ſame relation which the *ſulphureous* bears to the *ſulphuric acid*. The difference conſiſts ſolely in this, that there is in the *phoſphoric acid* a greater proportion of oxygen, in the *phoſphorous acid*, a ſmaller proportion of this acidifying matter. When rubbed, and ſtill more when heated, the *phoſphorous acid* takes a fœtid and diſagreeable ſmell. A part of it is then volatilized in a very acrid and pungent, white vapour. But, the acid is never wholly volatilized into ſuch vapours. The *phoſphorous* may be prepared by the decompoſition of the *phoſphoric acid*; and in the production of *phoſphorus*, there is always a certain quantity of the weaker acid diſengaged. This weak acid is ſaid by M. *Sage* to be non-deliqueſcent. Its other properties have not as yet been, all, carefully examined.

Theſe are the acid compounds of *phoſphore* with oxygen.

7.
Action of water on phoſphore:

In hot *water*, PHOSPHORE, becomes liquid. Even in cold water, it gradually loſes its tranſparency, becomes yellow, is covered over with an effloreſcence, and communicates to the water, the properties of acidity, and of a power to appear luminous when agitated in the dark. *Phoſphore* immerſed into ſolutions of the cauſtic fixed alkalis, under a boiling heat; affords by the decompoſition of the water of the ſolution, a compound of phoſphore with gas-hydrogen; which was firſt diſcovered by M. *Gengembre*, and has received the name of PHOSPHORATED HYDROGENOUS GAS. Its ſmell is fœtid; and it poſſeſſes the property of kindling with an

Phosphorated hydrogenous gas.

explosion, when it is brought into contact with atmoſpheric or with vital air.

8.
ction of
tric acid
n phoſ-
hore.

Concentrated *nitric acid* acts with violence upon PHOSPHORE. If the *phoſphore* be hot, the acid kindles it with great rapidity; and affords *phoſphoric,*—or if the combuſtion be [illegible] and ſlow, *phoſphorous-acid*, as the reſult of the reaction of theſe two ſubſtances upon each other. It is eaſily ſeen, that, in this inſtance, the nitric acid is decompoſed, and the phoſphoric acid formed; becauſe the attraction, between oxygen and phoſphore, is ſtronger than the attraction between oxygen and azote.

9.
ombina-
on of ſul-
hur with
hoſphore.

PHOSPHORE combines with *ſulphur* by fuſion and diſtillation. The reſult is a ſolid compound of a fœtid ſmell, which burns with a yellow flame, ſwells in water, and communicates to this fluid, the acidity and the odour of those compounds which are known by the name of alkaline ſulphures. The union of theſe bodies occaſion, as it ſhould ſeem, the decompoſition of a part of the water. This *ſulphure of phoſphorus*, or *phoſphure of ſulphur*, is far more ſoluble than either of its principles taken ſeparately. *Sulphuric acid* diſſolved with PHOSPHORE in a retort, burns it almoſt entirely, but by a ſlow, not a rapid combuſtion. The attraction between oxygen and phoſphore, is indeed ſtronger than that between oxygen and ſulphur; yet not ſo remarkably ſtronger as it is in compariſon with the attractions between oxygen and azote in the nitric acid.

10.
ſe of
hoſphore.

The luminous writing made with a ſtick of phoſphorus uſed in the dark, and in the open air, is ſufficiently known. Some trials of phoſphorus and its acids have been made in medicine. It has not yet been applied to any wide variety of other uſes.

11.
Extraction of phoſphor from bones.

The proceſs for extracting phoſphore from bones, is, as follows. Powder the bones. Paſs the powder through a ſieve. Add to it ſulphuric acid. You will obtain phoſphoric acid in a glaſs, beſide a quantity of other ſalts to be elſewhere explained.

SECTION FIFTH.

MURIATE AND ITS IMMEDIATE COMPOUNDS.

BOOK V.
SECT. V.

1. Intimate nature of muriate unknown.

By ſucceſſive proceſſes, we obtain from ſea-ſalt a ſubſtance known by the name of the MURIATIC ACID. This acid, analogy, and every thing ſave actual decompoſition, has taught modern chemiſts to regard as a compound in which oxygen is united, as in the other acids, with a particular baſe. Some chemiſts have occaſionally fancied; that they had ſucceeded in analyſing MURIATIC ACID into its component principles, and had diſcovered the nature of MURIATE. But, this idea has not been ſatisfactorily confirmed by the repetition of their proceſſes. MURIATE therefore is hitherto conſidered as the *unknown baſe* of MURIATIC ACID. The attraction between oxygen and this unknown baſe, ſeems to be ſtronger than any other attractions which we can employ to overcome it.

2. Liquid muriatic acid.

MURIATIC ACID, this compound of oxygen with an unknown baſe, poſſeſſes a very diſtinct and remarkable character as an acid. In its perfect purity, as a liquid, it abſolutely colourleſs. If ſtrong and concentrated, it exhales a white ſmoke upon being expoſed to the air. Its ſmell vivid and penetrating; and when the acid is weak or much diluted, reſembles the ſmell of the apple known by the name of the *golden rennet*. It communicates to the ſyrup of violets, and to all other blue vegetable colours, a deep red tinge, but does not abſolutely deſtroy them. In this liquid ſtate, it is denominated the *fuming muriatic acid*. But this is properly, as has been ſatisfactorily evinced by the

perim

ments of PRIESTLEY, only an aqueous dilution of the acid.

3. Proceſs to obtain muriatic-acid-gas.

o obtain the genuine *gazeous acid* in a ſtate of purity, ollowing proceſs may be employed. Heat the liquid ng acid in a retort hâving its extremity connected with l-glaſs inverted over mercury. The gas, which is much volatile than water, will ſpeedily paſs from the retort the bell-glaſs: And you will then perceive the acid- its diſtinct and peculiar form. Or, into a tubulated t, put 3 parts of decrepitated ſea-ſalt, with 1 part of g ſulphuric acid: The ſulphuric acid combining with ſoda of the ſea-ſalt, will expel the *muriatic acid* in its ſtate: And the latter acid may then be received n inverted glaſs with mercury: In order to prevent art of the acid-gas from eſcaping, *Wouſe's* apparatus, erly deſcribed, may be uſefully employed.

4. Phyſical characters of this acid-gas.

this gazeous ſtate, the MURIATIC ACID is more pon- s than common air. It has a keen and poignant r. Its cauſticity is ſuch as to inflame the ſkin, and to ion violent itchings. It ſuffocates animals. Poured the flame of a taper; it firſt expands it, and makes me around the edges, a green or blueiſh flame; then t extinguiſhes it. It is ſubject to be abſorbed by all y bodies. In *appearance*, it differs not from common

5. Action of light upon it.

t does not act with any ſenſible altering force upon acid-gas.

6. Of caloric.

t rarifies it, and increaſes its elaſticity. Its quantity ewhat diminiſhed by the action of the electric ſparks g through it.

7. Action of water on muriatic-acid-gas.

e *moiſture* of the atmoſphere when brought into con- with MURIATIC-ACID-GAS, clouds it and reduces it to-

wards

wards the ſtate of the liquid acid. *M. D'Arcet* has obſerved, that atmoſpheric air, when exceedingly dry, does not produce ſuch an effect upon MURIATIC-ACID-GAS. The inference is obvious. With *liquid water*, the *acid-gas* combines with ſufficient readineſs. *Ice* coming into contact with this gas, inſtantly melts to abſorb it. Uniting with this gas, water becomes conſiderably hot: But, after the union has taken place, the combination becomes ſufficiently cool. The moſt concentrated and pure *liquid* MURIATIC ACID is obtained by ſaturating pure water with the elaſtic fluid. It is certain, that the heat produced in water, when it is united with muriatic-acid-gas, can proceed only from the diſengagement into a free ſtate, of a part of the *caloric* which was neceſſary to give the gas now liquified, the expanſion of the gazeous form.

8. Oxygenation of MURIATIC ACID: Neither the *liquid* nor the *gazeous* MURIATIC ACID enters into any deciſively apparent combination with *vital air* in its *elaſtic fluid* form. It has indeed been affirmed, that by violent agitation the *liquid* MURIATIC ACID may be made to abſorb a portion of *vital air*. But, it is more certain, that this acid is ſuſceptible of a *ſuper-oxygenation*; the diſcovery of *Scheele*, and after him, of *Berthollet*. This *ſuper-oxygenation* is produced by the diſtillation of the concentrated liquid MURIATIC ACID with a ſubſtance with which we ſhall hereafter become more particularly acquainted under the denomination of *Black oxyd of mangaueſe*. The product of the diſtillation, received through water in a

Qualities of OXYGENATED MURIATIC ACID. ſuitable pneumatico-chemical apparatus; diſcovers itſelf firſt in the form of yellow vapours; and afterwards aſſumes a concrete form, and falls in cryſtals to the bottom of the liquor into which it is received. In a liquid form, this new ſalt has a harſh, though not an acid taſte. It whitens and deſtroys

ible colours, without changing them at all. BOOK V. SECT. V.
ate. Heated with lime, it gives out gas-oxygen,
ble of which, it muſt again return into the ſtate
muriatic acid. Paſſing from the ſuper-oxygen-
that of ordinary MURIATIC ACID, it always
sible colours. In its concrete form, it is cryſ-
quadrangular priſms, truncated very obliquely;
ed by a lozenge. It is ſuſceptible of the gaze-
well as the common MURIATIC ACID. In con-
the experiments of *Berthollet*, it is now general-
ching. It has been recommended to make
manuſcripts, clearly legible; as alſo for
een or yellow wax. It is commonly known
pellation of the *oxygenated muriatic acid*.

ic MURIATIC ACID is ſuſceptible of a very rapid 9. NITRO-MURIATIC ACID.
with the *nitric acid*. The compound which this
ces, is known by the name of *aqua-regia*, or the
ATIC ACID. It appears from the experiments of
RGMAN, and laſtly of BERTHOLLET; that the *ni-*
acid is nothing but MURIATIC ACID ſuper-oxygen-
olding, beſides, in combination with itſelf a por-
gas. A comparatively ſmall portion of ni-
be ſufficient to produce, by intermixture with
the new compound of *aqua-regia*. A part of
acid employed, attracting oxygen from the nitric
ſſipated in the form of oxygenated muriatic
the reſidue that appears as nitro-muriatic
ized acid is inferior in ſpecific gravity, to
acids of which it is compoſed. Its ſmell
colour commonly a citron-yellow. *Light*
a portion of *gas oxygen*. *Heat* ſeparates
ted muriatic acid-gas. It combines in any
proportion

BOOK V. SECT. V.

proportion with *water*; and while the combination place, caloric is given out. It is much uſed in chem and in the art of aſſaying,—as will hereafter more pa ly appear.

10. Reaction between the ſulphuric, and the muriatic acids.

Sulphuric acid readily unites with the MURIATIC *Heat* is execited when they are mingled together; muriatic acid gas is then plentifully diſengaged in vapours. It is affirmed by *Boeerhaave*, that MURIATIC renders *oil of vitriol* concrete.

11. Uſes of the muriatic acid.

The MURIATIC ACID is made uſe of, in the art of ing in the humid way; and in ſeveral others of the In medicine, dilutions of this acid in water, ar miniſtered, as diuretic, antiſeptic, cooling. It is exte applied, as an eſcharotic, as a cure for the gangrene i throat, aphthæ, &c. Mixed with water, it compoſes a for the feet, which ſome people employ as a ſpecif draw the gout from the more vital to the inferior par

SECTION SIXTH.

BORACE, AND ITS IMMEDIATE COMPOUNDS.

BOOK V.
SECT. VI.

1.
Whence obtained.

OM India, Perſia, and China, from the manufactures Holland, and of Paris, from ſome lakes in Tuſcany, out a cubic quartz of Limeburgh, of which a ſpecimen was lyſed by *M. Weſtrumb* ; we obtain a ſubſtance which is ll known in commerce by the name of *Borax*. That bſtance is not ſimple, but a compound. A chemical pro- ſs reduces it to a ſtate of greater ſimplicity. Seeing the alities which the product of this laſt proceſs, exhibits ; infer from them the exiſtence of ſuch a ſubſtance as ACE, the baſe of an ACID which we call the BORACIC ID, and affording this compound by a ſecret natural com- ation with oxygen. It is analogy alone which aſſures of the exiſtence of the ſubſtance which we call BORACE. t, that analogy is ſo fair, plauſible, and rational ; that, may ſafely venture to confide in it.

BORACE.

2.
Origin of the BORACIC ACID.

The BORACIC ACID, the compound of BORACE with oxy- n, has been found by *Hoefer*, in diffuſion, in the waters the lake Cherchiajo, near Monte-Rotando, in the terri- y of the Lower Siennefe ; in the waters alſo of the lake Caſtelnuovo ; and even in the mines of Tuſcany. It firſt extracted from *borax*, by a once celebrated French miſt of the name of Homberg. It ſeems to have its igin from the putrefaction of fat bodies.

3.
Obvious qualities of this *acid*.

It is a concrete matter, cryſtallized in ſmall white ſcales, y thin, irregularly formed, figured round the edges, ex- mely light, and ſometimes glittering. Its taſte is faint, ſenſibly acid. It communicates a faint redneſs to the colour

BOOK V. SECT. VI.

colour of tincture of violets. On tincture of turnſole, lows, radiſhes, &c. its effect is much ſtronger. It is volatilized upon expoſure to heat; but a red heat mel into a tranſparent glaſs. This glaſs, when expoſed to air, becomes opaque, and is covered with a white The glaſs is the boracic acid, unaltered: When diſſo in water, and, made to cryſtallize, it reſumes its granul form.

4. Its combination with water.

In *water*, this acid diſſolves, but not without diffic Not more than 183 grains of the acid can be diſſolved a pound of boiling water. By cooling and partial eva tion, the diſſolved acid may be reſtored to its cryſtal form. The aqueous ſolution of BORACIC ACID red tincture of turnſole, and ſlowly alters the colour of ſy of violets. BORACIC ACID, if moiſtened with a ſmall qu tity of water, and heated in a cucurbite, which is fi with a capital; ſuffers a volatilization of part of the with a part of the water: But, after the whole of the ter has been evaporated, the volatilization of the ceaſes: So that, it appears to have been only in co quence of its union with the water, that the acid was in former inſtance volatilized. Sublimated in this proceſs, acid preſents itſelf in a beautiful, ſparkling, cryſtalline fo It is in this ſtate very pure, and is known in pharmacy the name of *Sublimated Sedative Salts*.

5. Reaction between BORACIC ACID and the other acids.

The action of the other acids upon the BORACIC ACI not well known. If *Sulphuric acid* be diſtilled upon it BORACIC ACID produced a partial decompoſition of other. The conſequence of the diſtillation, is, a redu of the ſulphuric into the ſtate of ſulphureous acid. *nitric* and the *muriatic* acids diſſolve the BORACIC But, the phænomena which take place upon this occ have not yet been ſufficiently obſerved, to enable us to determine, whether the decompoſition be mutual.

BOOK V. SECT. VI.

6. Attractions and uſes of this acid.

In its attractions, the BORACIC ACID is the weakeſt of all known acids. Narcotic virtues were once aſcribed to it in a very eminent degree, as a medicine. But, is now little uſed in the *Pharmacopæia.*

SECT.

SECTION SEVENTH.

OF FLUORE, AND ITS MORE IMMEDIATE COMPOUN

BOOK V. SECT. VII.

1. FLUORE, Whence obtained.

DIFFUSED throughout the mineral kingdom of na
great abundance, we find a ſubſtance which has rece
the appellation of *Fluor-Spar*. It abounds eſpecially i
vicinity of veins of metallic ore. It has a cubic form,
treous aſpect. It is plentiful at the mines of Derby
England; and from this circumſtance, popularly kno
Britain, by the name of *Derbyſhire Spar*. From thi
ſtance, chemiſtry obtains by diſtillation with ſulphuric
another and peculiar acid, which from the ſubſtance o
which it is obtained, has received the name of the FLU
ACID. FLUORE is the baſe of this acid; but has no
been ſeparated from the oxygen by which it is acidif

2. Phyſical qualities of the FLUORIC ACID.

The character of this *acid* was, for the firſt time,
factorily explained by thoſe illuſtrious *Swediſh* che
SCHEELE and BERGMAN. When pure, it has a ga
form; is more ponderous than common air; extingui
lights; and ſuffocates animal life. Its ſmell is but little
pungent and penetrating than that of muriatic acid
Its cauſticity corrodes the ſkin.

3. Action of light and heat on it.

It ſuffers no ſenſible alteration from *light*. *Caloric*
pands it, but without changing its nature.

4. Its relations to water.

Its relations to *water* are more remarkable. It att
into combination with it, the moiſture of the atmoſp
In union with the *moiſture* thus attracted, the FLUORIC
GAS takes the form of a thick, white vapour. With
water, FLUORIC ACID GAS readily unites. There is
miſſion of caloric into a free ſtate, out of the acid

it of their union. Another remarkable phæno-
r which this combination is accompanied,—is—the
ı or precipitation out of the acid gas, of certain
f a fine white earth, with which we ſhall here-
nte more particularly acquainted under the deno-
of *Silice* or *Siliceous earth.* The *liquid* FLUORIC ACID
ecompoſed, like the liquid muriatic acid, by heat-
retort of which the extremity is connected with a
filled with mercury. The ACID, reſuming the
rm, paſſes out into the bell-glaſs; leaving the wa-

nd other properties of FLUORIC ACID GAS, which
ereafter have occaſion to ſtate, ſufficiently prove
peculiar acid; diſtinct from the muriatic acid.
her chemical inveſtigation ſeems requiſite to illuſ-
haracter fully.

5. It is but imperfectly known.

CID, whether liquid or gazeous, has not yet been
the ſervice of the arts. When proceſſes ſhall be
by which we may more eaſily obtain it; it may
ably be uſefully employed for many important
purpoſes.

6. Its uſes.

SECTION EIGHTH.

OF SUCCINE[*], AND ITS IMMEDIATE COMPOUNDS.

BOOK V.
SEC. VIII.

1.
Origin of this ſubſtance.

FROM the bowels of the earth, and on the ſea-ſhore in the Pruſſian dominions; on the hills of Provence, near the town of Siſteron; in the marquiſate of Ancona, and in the duchy of Spoletto in Italy; in Sicily, Poland, Sweden; occaſionally on the north-eaſt coaſt of Scotland; and in various other countries; there is obtained a combuſtible ſubſtance, named SUCCINUM or *amber*, which appears under different varieties of form; is combuſtible; and affords by diſtillation, among other principles, a peculiar acid, known in modern chemiſtry, by the name of the SUCCINIC ACID. This acid has never yet been reſolved into its component principles. But, from the analogy of the other acids, with which it agrees in its generic properties, the SUCCINIC ACID has been plauſibly inferred to be a compound of OXYGEN the general acidifying principle, with a peculiar, unknown baſe. That unknown baſe, is what we denominate SUCCINE.

2.
SUCCINIC ACID.

Its combination with oxygen in the SUCCINIC ACID, ſhews itſelf in the receiver, as a product of the diſtillation of amber, in the form of a concrete ſublimate. Its ſmell is bituminous. It is cryſtallized in the form of needled cryſtals. It is ſuſceptible of many new combinations with other ſubſtances.

3.
Compoſition of SUCCINIC ACID

It is true, that late inveſtigations, together with the oleaginous appearance, and the inflammability of this acid have led chemiſts confidently to conclude its baſe to be a compound of hydrogen with carbon.

SECT.

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[*] Probably a compound of *hydrogen* with *carbon*.

SECTION NINTH.

OF ACETE, AND ITS MORE IMMEDIATE COMPOUNDS.

BOOK V.
SECT. IX.

1.
Origin of ACETE.

ANIMAL bodies, after the extinction of their vitality; vegetable ſubſtances, when the principle of vegetation has fled within them; liquids impregnated with animal and vegetable matters; are all ſubject to certain natural changes, by which their ſtructure is gradually and ſpontaneouſly deſtroyed, and they are reduced in a natural decompoſition to their uncombined elementary principles. All theſe changes are diſtinguiſhed in popular language, and even by philoſophers, under the two denominations of *Fermentation* and *Putrefaction.* Chemiſts, at length more accurately informed concerning what takes place in the progreſs of theſe decompounding changes; have applied to them all, the common and generic name of FERMENTATION; but have diſtinguiſhed three different ſtages of this FERMENTATION,—the *vinous* or *ſpirituous*,—*the acid* or *acetous*,—and the *putrid* or *putrefactive.*

A future occaſion will ariſe, to require us to ſurvey in all their detail, the phænomena of theſe three different ſtages of *Fermentation.* At preſent, we are to examine a particular *product* of that which is termed *Acetous Fermentation.* This product is *acetum* or *vinegar*, from the evolution of which, this particular ſort of fermentation, derives its name. Vinegar affords by diſtillation, a peculiar acid fluid which has been named with ſufficient propriety, in regard to two different ſtates of oxygenation, of which it is ſuſceptible, the ACETOUS or the ACETIC ACID. The decompoſition of this acid affords the baſe which we term ACETE.

2. Its natural compoſition.

This baſe has ſcarcely yet been exhibited by che
a naked ſtate. A deſcription of its phyſical pr
therefore, cannot here be given. It is, notwithſt
ſuſpected, from a very ſtrong and plauſible analog
itſelf, not ſo much a ſimple as a compound ſubſtan
elements are ſuppoſed to be two ſubſtances which ha
above deſcribed,—*Hydrogen* and *Carbon*.

3. The ACETOUS ACID.

The ACETOUS ACID, one of the products which
tained from vinegar by diſtillation, is clear, liquid,
It has an agreeable taſte and ſmell. Intenſe *heat*
poſes it. Even a moderate heat, with the acceſs
gradually alters it. It is always more or leſs four.
tion for a few minutes is neceſſary to bring it in
condition in which it may be beſt preſerved for
expoſed to the action of froſt; the ACETOUS ACID ſuf
congelation of any portion of water by which it
luted : but, what remains uncongealed by the froſt,
centrated acid. This acid appears to be almoſt
blended and contaminated with various other matte
in the pureſt ſtate in which it is ordinarily obtained

4. The ACETIC ACID.

Copper oxydated and diſſolved in ACETOUS ACID,
by the evaporation and cooling of the ſolution, gre
tals in truncated quadrangular priſms, or rather
form of beautiful pyramids. Theſe cryſtals, of wh
chemical name is, *acetite of copper* ; if they be reduc
powder, and diſtilled in a glaſs or earthen retort ;
fluid product, which is at firſt white and acidulo
becomes within a ſhort time ſo ſtrong, as to be not
in acidity to concentrated mineral acid. After the
acidulous product has paſſed ; it is neceſſary then to
the receiver ; that the ſtrong acid may be obtained ſe
This product is the ACETIC ACID. It appears to

ACETOUS ACID the ſame relation which the *oxygennated muriatic acid*, bears to the *muriatic acid*; or rather that relation which the *ſulphuric* bears to the *ſulphureous*, the *nitric* to the *nitrous acid*. It has acquired by attraction from the oxydated copper, an extraordinary proportion of oxygen. It is of a ſmell ſo lively and pungent, that it can ſcarcely be borne. Its cauſticity is ſufficient to corrode and cauteriſe the ſkin. It is extremely volatile and *inflammable*. Any quantity of it, will quickly diffuſe itſelf wholly away by evaporation in the air. It combines with *water*; giving out a conſiderable heat, while the combination takes place. It has been ſhewn by the *Marquis de Courtanvaux*; that nothing but the laſt portion of what the diſtillation of acetite of copper affords, is actually ſuſceptible of inflammation; and that this portion cryſtallizes by rectification, into plates and needles, and requires to reduce it to fluidity, a heat of more than 14° above the freezing point. The ACETIC ACID is uſed in the preparation of *acetic æther*, &c. It is to be wiſhed, that the nature of this intereſting acid were farther illuſtrated by the inveſtigations of chemiſts.

SECTION TENTH.

OF TARTARE, AND ITS IMMEDIATE COMPOUNDS.

OOK V.
ECT. X.

1
rigin of
ARTARE

BY the developements of that which is named *vinous fermentation*, as alſo from muſt, from verjuice, and from other vegetables in chemical proceſſes; we obtain a ſubſtance which is well known in commerce, by the name of *Tartar*. *Tartar* is, however, procured, moſt commonly, and in the greateſt quantities, from wine, by gradual depoſition upon the interior ſides of the caſks in which this liquid is repoſited. Chemical proceſſes of ſolution, heating, mixture, and evaporation, at length ſucceed ſo far as to preſent this ſubſtance of tartar in a purer ſtate, in which it is called *cream of tartar*. A new proceſs, ſaturating with lime, the ſolution of this *cream of tartar*; waſhing the ſolution, digeſting it with ſulphuric acid and water, and then evaporating and cooling the mixture; at length obtains in diſtinct and peculiar cryſtals, a new ſubſtance which is known by the name of the *tartareous acidulum*. This *acidulum* conſiſts of *tartareous acid* in combination with a ſmall proportion of a ſubſtance named potaſh, with which we ſhall very ſoon have occaſion to make ourſelves particularly acquainted. The diſtillation of this *acidulous* ſubſtance, and the ſubſequent lixiviation of the reſidue, evince in what proportion, potaſh is mixed in the acidulum with the component parts of the genuine acid. SCHEELE was the inventor of a proceſs in which *tartareous acidulum*; diſſolved in boiling water; mixed with a ſaturating quantity of chalk; combined with this chalk into the ſalt named *calcareous tartarite*; in this combination,

ion, filtered and waſhed with cold water; then
for the ſpace of twelve hours with a due propor-
iluted ſulphuric acid; affords over a precipitate of
of lime,—a liquor, that, by evaporation yields at
re TARTAREOUS ACID. A ſecond ſolution of that
iporated to dryneſs; and then an evaporation or
ng of this ſecond ſolution, to a ſyrup-conſiſtency;
t give this ACID in its genuine form of minute
r ſmall ſharp-pointed needles. Theſe have been
by *Bergman*, as divergent leaves; by *Retzius*, as
hairs intwined together. But in truth, their
ich, that it can ſcarce be determinately deſcribed.
at the firſt, very white; towards the end of the
, rather yellow.

2. Its nature and compounds.

baſe of this ſalt to which we would give the
ARTARE. This baſe has never yet been obtained
ſeparate. But, the decompoſition of the acid,
en effected with ſufficient ſucceſs, has ſerved to
the baſe is a compound, not a primary and ſim-
ice. Its component principles appear to be *hy-*
carbon. It is from what experiment has in this
y evinced, that the baſes of ſome other acids have
ialogy alone, concluded to be alſo compound.

3. The tartareous acid.

RTAREOUS ACID compounded of *hydrogen* and *car-*
nited for its *baſe*—with oxygen to acidify that
on; preſents itſelf, as was above noticed, in the
hite or yellowiſh, needled cryſtals. Brought in-
with bodies in *combuſtion*, it alſo melts, fumes,
lack, and even takes fire. However pure, it is
. By diſtillation it is decompounded into an
m, a ſmall portion of oil, a larger proportion of

BOOK V. SECT. X.

carbonic acid gas, and a mixture of carbonated hydroge gas. It is carbon unmixed with alkali, that forms the due in the retort. It is not liable to alteration in the Its taſte is very pungent. It reddens the tincture of lets, or of turnſole.

SE

SECTION ELEVENTH.

OF PYRO-TARTARE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of pyro-tartare.

THIS PYRO-TARTARE is not a diſtinct, well known, peculiar ſubſtance, often to be ſeen in a naked, inſulated ſtate, and incapable of decompoſition. It is the ſuppoſed baſe of an acid which is named the PYRO-TARTAREOUS, and is only a modification of the *tartareous acid*. This baſe is accounted a compound of hydrogen with carbon, juſt as well as the baſe of the acid laſt deſcribed.

2. The pyro-tartareous acid.

This PYRO-TARTAREOUS ACID in which the baſe, PYRO-TARTARE, is combined with oxygen, is the acid phlegm which paſſes as the firſt product into the receiver, in that diſtillation by which the *tartareous acid* is finally obtained. *Probably, amid the decompoſitions which take place in this diſtillation, there may be a new compoſition of water by the union of ſome portion of diſengaged hydrogen with oxygen from ſome other parts of the mixture: And this water, oil from the mixture under diſtillation, a portion of the hydro-carbonic baſe, and a due portion of oxygen joining this baſe; may then be the principles of which the pyro-tartareous acid is compoſed.* It is the action of heat, to which the oxygen of the PYRO-TARTAREOUS *modification* of the tartareous acid, is aſcribed. Its taſte and ſmell are empyreumatic. It reddens tincture of turnſole, and blue paper. It diſengages the carbonic acid from all the terrene and alkaline baſes with which it is known to be combined. It forms with theſe baſes, a particular claſs of neutral ſalts: And its entering into their formation, is the moſt remarkable of its diſtinctive properties. It does not cryſtallize. It is rarefied by heat.

SECT-

SECTION TWELFTH.

OF OXALE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of OXALE.

In Germany, and other places there is extracted from the wood of ſorrel, which Linnæus names *acetoſella*, a cryſtalline ſalt which may be obtained alſo from other plants. This ſalt appears in commerce, in the form of minute, white cryſtals. Expoſed to diſtillation, it affords a product of inodorous, colourleſs phlegm, which is the OXALIC ACID almoſt perfect and unaltered. The ſalt of ſorrel of commerce is what chemiſts call the *oxalic acidulum* But, it is the baſe of the acid obtained by diſtillation from the acidulum, which we would here diſtinguiſh as a peculiar ſubſtance, under the appellation of OXALE.

2. Nature of OXALE.

This OXALE has never yet been exhibited in a perfectly naked ſtate. But, the acid into which it is known to enter, has been decompoſed: And the decompoſition has evinced, that OXALE, like ſome others of the acidifiable baſes, laſt deſcribed, muſt be a compound of hydrogen with carbon.

3. Properties of the OXALIC ACID.

The OXALIC ACID, the compound of OXALE with oxygen, when obtained in the manner above deſcribed, or by a more complex, but in the end more completely ſucceſsful proceſs which has been recommended by Scheele, and will be hereafter explained; appears in quadrilateral priſms having their ſides alternately broad and narrow, and terminating in dihædral ſummits; or often alſo in ſquare o rhomboidal, cryſtalline plates. Its taſte is very ſtrongl ſour. Seven grains of the concrete oxalic acid are ſufficien to communicate a ſenſible acidity to two pounds of wate e grain of this ſalt, is ſufficient to communicate to rains of water, the property of reddening paper d with turnſole. Expoſed to a moderate *heat*, this comes dry, is covered over with a thick cruſt, is in time reduced to a powder, and loſes $\frac{3}{10}$ of its weight. tion by a ſtronger, yet not a very violent heat, li- it, embrowns it, partly affords from it an acidulous a, and ſublimates it in part, unaltered. At the ſame diſengaged from it, a gas containing a mixture of ic acid with gas hydrogen. Expoſed to a more vio- eat, this OXALIC ACID affords a larger proportion of ſmaller proportion of ſublimated, concrete acid, a proportion of acidulous phlegm, incapable of cryſ- tion, and leaves at the bottom of the retort, a grey wn maſs amounting to $\frac{1}{50}$ of the whole quantity of nployed. Put upon a burning coal in the open air, C ACID emits a very acrid white ſmoke, by which ngs are irritated in a very lively manner. The reſi- hich it leaves in this laſt proceſs, is white, without ixture of carbonaceous matter. Expoſed to *moiſt* air, ncrete OXALIC ACID becomes deliqueſcent. In dry rather becomes more dry. Cold *water* diſſolves of it tity equal to more than half its own weight. The c gravity of the cold ſolution is, according to *De u-Guyton*, 1,0593. No acid vapour ariſes with the of this ſolution, by either evaporation or ebullition. g water diſſolves of this acid, a quantity equal to it- weight: Of this, one-half is, by cooling, precipitated ſtals.

4. Its uſes.

: pure *oxalic acid* is uſed only in the laboratory. It is vegetable acids, the moſt oxigenated, and the leaſt poſable.

SECT-

SECTION THIRTEENTH.

OF GALLE, AND ITS IMMEDIATE COMPOUNDS.

BOOK V. SEC. XIII.

1. Origin of the GALLIC PRINCIPLE.

THE huſks of nuts, the bark of the oak, and eſpe the nut-gall afford a ſubſtance which was formerly the aſtringent principle, and which is alſo to be fou various other vegetable matters. It has more recently termed the *Gallic Acid.* It is the baſe which is in thi ſtance combined with oxygen, to which we would giv name of GALLE. That baſe has not yet been obtai a pure naked ſtate, detached from its oxygen. But, lyſis has diſcovered that this baſe alſo is not a pure, ſubſtance, but a compound of *hydrogen* with *carbon,* ſu might, with ſufficient propriety be named HYDRO-CA

2. Compoſition of ITS ACID.

This acid, the compound of this HYDRO-CARBON oxygen, is commonly obtained by macerating nut-ga water.

3. Qualities and relations of this acid.

The GALLIC ACID appears in the form of minute, or yellowiſh, needled cryſtals. Its taſte is ſour, ſtiptic, aſtringent. Its infuſion reddens turnſole and blue p The other acids diſſolve it. The *nitric acid* changes character to that of *oxalic acid*, probably by furniſhi with additional oxygen. *Heated* in contact with *air*, cryſtals of this acid ſwell up, are burnt, and leave a c reſidue which cannot be eaſily incinerated. Subjected diſtillation by a gentle heat, this acid yields—as the product,—a part of the acid in union with the water wh it retained in its cyſtallization,—then, a ſublimate of decompoſed acid, in the form of ſilky cyſtals,—at laſt, by the application of a ſtrong heat, a few drops of oil,

of gas hydrogen, and carbonic acid gas. The
CID is ſoluble in 24 times its own quantity of cold
n 3 times its own quantity of boiling water. It
es moſt of the metals from their ſolutions; and
rticularly with iron that uſeful precipitate—*writing*
alſo uſed in dyeing cloths of a black colour. The
LIC ACID, if uſed in the preparation of ink, affords
hat is very black, very beautiful, and remains long
l.

4.
SCHEELE's proceſs for obtaining the GALLIC ACID.

luſtrious SCHEELE firſt invented that proceſs,—dif-
om mere maceration of the nut-gall in water, which
his acid in its concrete and cryſtalline form. It is,
s. Reduce a pound of nut-galls into powder; and
n it ſix pounds of diſtilled water: Leave this mix-
acerate for the ſpace of 15 days at a temperature
68° to 77°. Then filter this liquor; and after
ion, expoſe it in a veſſel of glaſs or ſtone-ware, to
ſlowly in the air. During this evaporation which
ontinued during 2 or 3 months, the pure acid will
ted in cryſtals, on the ſides and bottom of the
d on the inferior ſurface of a pellicle which will
led over the mixture. At the end of this period,
he liquor. Then diſſolve in alcohol or ſpirit of
atever remains in the veſſel. This laſt ſolution,
l, will afford the pure GALLIC ACID in cryſtals.

SECT.

SECTION FOURTEENTH.

OF CITRE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of CITRE; and of the CITRIC ACID.

THE acidity of *lemon-juice* is well known. Various attempts have been made to purify it, ſo that it might admit of being long preſerved in bottles for uſe. But the mucilage which it in its natural ſtate, always contains in a great proportion; renders this exceedingly difficult. The proceſs by concentration with cold, has been adopted as the moſt common, and the moſt eaſily effectual. An improved proceſs of this ſort, was deſcribed by *M. Georgius* in the *Acts of the Academy of Stockholm for the year* 1774. This proceſs conſiſts chiefly in freeing the lemon-juice by congelation, from the aqueous and mucilaginous matter with which it is in its ordinary ſtate contaminated: And then in concentrating this purified juice by a new congelation; till a drachm of it ſhall be ſufficient to ſaturate 36 grains of potaſh. *M. Dubuiſſon* accompliſhed the ſame purification and concentration of lemon-juice by evaporation with a moderate heat, long continued. The mucilage was in this proceſs gradually ſeparated in the form of a cruſt and gelatinous flakes.—The acid liquid which remained, wa concentrated, and was ſuſceptible of being long kept, without ſuffering alteration, in well ſtopped bottles. In the yea 1784, SCHEELE gave, in *Crell's Chemical Journal*, a proceſs fo obtaining this acid in more perfect purity than it had bee afforded in, by any former proceſs. This proceſs conſiſted chiefly—in ſaturating boiling lemon-juice with chal—then, waſhing the precipitate, which was *citrate of lim* in lukewarm water;—and *next* employing ſulphuric

BOOK V.
SEC. XIV.

ch the lime, and leave the CITRIC ACID naked and ſe-
te. It ſucceeds perfectly.

2.
Nature of the CITRIC PRINCIPLE.

t is the baſe which is in this CITRIC ACID, combined
h oxygen, that receives from us the name of CITRE.
has never yet been obtained in an abſolutely naked ſtate.
t the decompoſition of the acid, has evinced the baſe to
a HYDRO-CARBONOUS compound.

3.
Qualities of the CITRIC ACID.

The CITRIC ACID having this origin, and being thus com-
nded, is cryſtallized in rhomboidal plates; is ſubject to
ntaneous decompoſition under the action of either *fire*
r water; has a ſtrongly acid taſte; reddens all blue vege-
ble colours; ſuffers no alteration from the influence of
t. It is certainly one of the moſt powerful of all thoſe
ds which are underſtood to be peculiar to vegetables.
Its powers of action upon the earths, alkalis, and me-
s, which will be hereafter explained. The CITRIC ACID
ed in various preparations for the table. It is employ-
in medicine, as cooling, temperating, antiſeptic, antiſcor-
c, diuretic. It is ſometimes applied as a gentle eſcharotic
rbutic ulcers, eruptions of the itch, and ſpots on the
n. Concentrated by the proper proceſſes, it is very ad-
ageouſly uſed in long ſea-voyages.

SECT.

Malle, and its Compounds.

SECTION FIFTEENTH.

OF MALLE, AND ITS IMMEDIATE COMPOUN

[illegible] fruits, but more eſpecially apples, afford [illegible] sour juice; which, if ſaturated with *potaſh*, mi [illegible] *acetite of lead*, precipitated from this mi [illegible] with the lead, and in this form trea [illegible] acid; at laſt affords pure MALIC ACID [illegible] liquid ſtate. The baſe of this acid, a co [illegible] hydrogen with carbon, is the ſubſtance to w [illegible] the name of MALLE.

The pure MALIC ACID is eaſily deſtructible by th [illegible] which converts it into carbonic-acid-ga [illegible] with gas-hydrogen. It is the oxygen of th [illegible] is combined with the carbon, in the ne [illegible] acid. The *nitric acid*, yielding its ox [illegible] of the malic acid, thus alters the propor [illegible] that baſe and the acidifying principle, and [illegible] into oxalic ACID. The pure MALIC AC [illegible]. With earths, alkalis, and metals, th [illegible] forms peculiar neutral ſalts. Its contributin [illegible] of theſe, is its principal diſtinctive [illegible] found this MALIC ACID almoſt pure, o [illegible] with but a little citric acid, in the juice of a [illegible], of alder-twigs, of the ſloe-thorn, [illegible] of the plum-tree; in gooſe-berries, cherri [illegible] raſp-berries, &c.

1. Origin of BENZOE.

her vegetable products named *Storax*, *balſam of*
lu, *cinnamon*, we obtain by ſublimation with a
by heating it with water, and by a new pro-
ention of SCHEELE, an acid which is known in
the name of the BENZOIC ACID. The HYDRO-
baſe of this acid, is what we here term BEN-

2. Proceſs for obtaining the BENZOIC ACID.

eſs of SCHEELE employs lime-water as its prin-
n. Slake four ounces of *quicklime* with twelve
vater. When the ebullition has ceaſed, add
s more of water. Mix by agitation, ſix ounces
-water with one pound of benzoin in powder.
ll the remainder of your lime-water to the mix-
ſe it for half an hour, under inceſſant agitation,
of a gentle heat. Then leave it for ſeveral
ol and ſettle, undiſturbed. Decant off the clear
liquor. Boil the reſidue for half an hour with
s of additional water. After ſubſidence and
add alſo this ſecond quantity to the clear fluid
boiling. Let the reſidue be again repeatedly
decanted lixivia to thoſe formerly de-
part. Evaporate the whole liquor to
two pounds. Suffer the remainder to

CID. Subſequent edulcoration; ſolution in five or ſi times its weight of boiling water; filtration; and ſlow cooling; will preſent this ACID in its moſt perfect cryſtallin form.

3. Character of the BENZOIC ACID.

In this concrete form, the BENZOIC ACID appears in cry talline compreſſed priſms. It yields to heat with an ar matic odour. It is fuſible by a gentle heat. It is vola but not readily ſoluble in cold water; ſoluble, but not d compoſable in nitric acid. Its taſte is pungent, hot, a acid. It communicates an high red colour to tincture turnſole. The concentrated ſulphuric acid diſſolves it wi eaſe, and without either noiſe or heat; but paſſes itſelf conſequence of this reaction, into the ſtate of *ſulphureous a cid.* Water again ſeparates the BENZOIC ACID unalter from the ſulphureous acid. Expoſed to intenſe heat, th BENZOIC ACID evaporates without inflammation. Air ſeem to have no power of action upon this acid; for a quanti of it remained ſtill very pure, after being preſerved for a bout twenty years in a glaſs veſſel. 400 grains of cold water diſſolve but one grain of BENZOIC ACID: But, of boiling water 24 parts will diſſolve 1 part of this acid.

SECT

SECTION SEVENTEENTH.

OF PYRO-LIGNE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of PYRO-LIGNE.

BEECH, birch, box trees, and other timber, afford by diſtillation a peculiar acid. That acid ſeems to owe its origin in part to the action of fire; and is, therefore, named the PYRO-LIGNEOUS ACID. To its HYDRO-CARBONOUS baſe we give the name of PYRO-LIGNE.

Boerhaave was not unacquainted with this acid. But, its nature was firſt tolerably explained by *M. Goettling*, in a memoir publiſhed in the year 1779, in *Crell's Chemical Journal*. By diſtillation of the bark of the birch-tree in an iron retort, Goetling obtained a brown, oily, acid product. This he left to ſettle for three months. At the end of that time, filtration was employed to ſeparate ſome ſmall portion of oil which had been developed. The filtered liquor, then, being ſaturated with potaſh, and evaporated, afforded a black ſalt; which a ſecond ſolution, and then a ſecond evaporation, reduced into the ſtate of tolerably pure PYRO-LIGNEOUS ACID. The chemiſts of the *Academy of Sciences of Dijon* extracted the PYRO-LIGNEOUS ACID by diſtillation from beech-wood; and afterwards rectified the liquid product. 55 Ounces of ſhavings of the dried wood, afforded 17 ounces of rectified acid. The *hydro-carbonous baſe* of this acid, thus obtained, is the principle which we call PYRO-LIGNE.

2. Characters of PYRO-LIGNEOUS ACID.

This acid cannot be obtained in a concrete form. It is of an amber colour. Its gravity is to that of diſtilled water in the proportion of 49 to 48. Expoſed to a gentle heat, it is made to aſcend in vapours. A ſtrong heat decompoſes this, as well as the other vegetable acids.

SECTION EIGHTEENTH.

OF PYRO-MUCE, AND ITS IMMEDIATE COMPOUND

BOOK V. S. XVIII.

1. Origin of PYRO-MUCE.

INSIPID, ſaccharine, gummy, farinaceous mucilage
jected to diſtillation, afford an acid phlegm, whic
modern chemiſtry, denominated the PYRO-MUCOU
The baſe of this acid is merely an *hydro-carbonous* com
We give it the name of PYRO-MUCE. This acid
is ſuſceptible of a rectification with clay, which af
in a clearer and leſs empyreumatic ſtate, than that in
it appeared at the firſt.

2. Qualities of the PYRO-MUCOUS ACID.

This ACID does not preſent itſelf in a cryſtallize
but may be concentrated by a congelation which ſh
vert its aqueous part into ice. It has an agreeabl
of caramel. It reddens blue vegetable colours; and
it falls upon the ſkin, occaſions a red ſpot. Inte
applied to it in a diſtillation cautiouſly managed i
veſſels, decompoſes it into carbonic acid gas and
drogen.

SECTION NINETEENTH.

OF CAMPHORE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of CAMPHORE,

ROM a variety of vegetables, but eſpecially from a particu-ar ſpecies of bay-trees, growing in China, in Japan, in iſles of Borneo, Sumatra, Ceylon, &c. is obtained a ſub-nce named CAMPHOR which is much uſed in medicine, which chemiſts ſuppoſe to be an immediate principle vegetables. Nitric acid diſtilled eight times ſucceſſively h this ſubſtance, produces a peculiar acid. To the baſe h is, in this peculiar acid, combined with oxygen, we give the denomination of CAMPHORE. It is merely an *carbonous* compound.

2. Character of the CAMPHORIC ACID.

is CAMPHORIC ACID, thus obtained, preſents itſelf in lipiped cryſtals; is bitter to the taſte; and is capable mmunicating a red colour to tincture of violets and le. It forms peculiar neutral ſalts with the earths, , and metals. It is, as yet, but very imperfectly

NTIETH.

MEDIATE COMPOUNDS.

BOOK V. S. XVII

Origin of PYRO-M

covered by *M. Brugnatelli*, t ch had been diſtilled four ti acid, afforded a yellowiſh th character. The baſe which w by oxygen, may be denomi nothing but an *hydro-carbonous* co

Qual the MUC CID

is incapable of cryſtallization; ha ter taſte; when evaporated by a ſtro of a viſcid maſs, like wax, and ſo ſ moulded with the fingers. On burni reduced to a coal, without inflam

SE

SECTION TWENTY FIRST.

OF LACTE, AND ITS IMMEDIATE COMPOUNDS.

1. Origin of LACTE.

THERE is obtained, as is well known, from *milk* and *whey*, a ſour ſubſtance which chemiſts have, with great propriety, denominated the LACTIC ACID. This acid is obtained by evaporating the whey, after filtration, to $\frac{1}{8}$ part of its original quantity; precipitating the reſidue with lime-water; diluting the ſuper-natant fluid with three times its own weight of water; precipitating the lime from this diluted liquor, by oxalic acid; evaporating the purified liquor to the conſiſtency of honey; and then, by means of pure *ardent ſpirit* detaching from this ſubſtance, the LACTIC ACID; which will deſert whatever other ſubſtances may yet remain with it, and will combine alone with the ardent ſpirit. The decanted ſolution being anew diluted with water, and heated, will loſe the ardent ſpirit by its flying rapidly off into the air, ſo that the pure LACTIC ACID will now remain, alone, diſſolved in the water.

2. Its compoſition.

To the acidifiable baſe of this LACTIC ACID, we give the name of LACTE. It is not ſimple. It is moſt probably a compound of *hydrogen*, *carbon*, and *azote*.

3. Nature of the LACTIC ACID.

The LACTIC ACID is not cryſtallizable. It attracts moiſture from the atmoſphere. It is decompoſable by diſtillation. It forms peculiar deliqueſcent ſalts with the earths and alkalis.

SECTION TWENTY SECOND.

OF SACCHO-LACTE, AND ITS IMMEDIATE COMPOUNDS.

OOK V. XXII. 1. rigin of ACCHO-ACTE. THE whey of ſweet milk, affords by a lengthened proc of evaporation and clarification, a ſubſtance named *ſug milk,* which is commonly manufactured in Switzerla This ſubſtance, like common ſugar, when heated with tric acid, affords a new product of *oxalic acid.* But, t reſidue of ſugar of milk from which *oxalic acid* has th been obtained, if farther diluted in water, and then filt ed, leaves upon the filter a *white powder* which is found poſſeſs all the properties of a new and peculiar acid. T compound baſe of this acid, is—SACCHO-LACTE.

2. ature of e SACCHO-ACTE ACID. The SACCHO-LACTIC ACID thus obtained, never appe in the cryſtalline form. It deliqueſces, if expoſed to t free acceſs of the open air. It is not eaſily ſoluble. I taſte is almoſt inſipid. Fire decompoſes it; and it th affords a *ſublimate,* having the mixed odour of benzoin a amber,—a brown liquor not of an oleagineous character, and a reſidue of carbonaceous matter in the retort. Du ing the proceſs, there is alſo a diſengagement of both g *hydrogen* and *carbonic acid gas.* An ounce of boiling wa diſſolves only ſix grains of SACCHO-LACTIC ACID: And ev of this portion diſſolved, there is $\frac{1}{4}$ part precipitated cooling.

SEC

SECTION TWENTY THIRD.

OF FORME, AND ITS IMMEDIATE COMPOUNDS.

BOOK V.
S. XXIII.

1.
Origin of FORME.

ANTS, and eſpecially the great ant, *Formica Rufa*, afford either by diſtillation in a retort, or by lixiviation with boiling water,—a peculiar acid. To the compound baſe of this acid, we give the name of FORME.

2.
Nature of the FORMIC ACID.

The FORMIC ACID. even in the living inſect, communicates a red colour to the blue flowers of vegetables. It is evolved in a ſtrongly odorate vapour. Its ſmell reſembles that of muſk. In this gazeous form, it is fatal to animal life. It may, however, be adapted to the ſame domeſtic uſes, as vinegar. It attracts oxygen from the oxygenated muriatic acid. It is often ſtronger than ſulphuric acid. Intenſe heat decompoſes it. This decompoſition yields the products *of carbonic acid gas, gas hydrogen*, and ſome [illegible] matters. It forms with the earths, alkalis, and metals peculiar, cryſtallizable, and non-deliqueſcent, neutral

SECT-

SECTION TWENTY FOURTH.

OF PRUSSE, AND ITS IMMEDIATE COMPOUNDS.

Iron and various animal matters,—particularly bulloc blood, the hair, horns, hide, and hoofs of animals,—aff by a lengthened and complex proceſs, which we ſhall e where deſcribe, a blue ſubſtance which, from its having be firſt manufactured in *Pruſſia*, has been denominated PRU SIAN BLUE. The reſearches particularly of SCHEELE, and the chemiſts of the *School* of LAVOISIER, have at laſt ſhow that the principle to which the formation of this blue co louring matter is to be aſcribed, deſerves to be regarded a *peculiar acid*. This acid is now known by the name the PRUSSIC ACID. We have therefore attributed to compound baſe, the denomination of PRUSSE.

The PRUSSIC ACID is remarkable for a fœtid, noxio odour. It is eaſily decompoſed by intenſe heat; yieldin in the decompoſition, ammoniac, with other ſubſtanc is reducible to a gazeous ſtate. It may be, at any tim formed by the combination of hydrogen, carbon, azo and oxygen in the due proportions. The proportion oxygen which it ordinarily contains, ſeems to be very ſma It is capable of detaching oxygen from the oxygena muriatic acid. In conſequence of being thus ſuper-ox genated, it ſuffers a great change of character. Its ta in its ordinary ſtate of oxygenation, is but faintly acid. E poſure to light, in its ſuper-oxygenated ſtate, renders it incapable of combination with oxyd of iron, or with wat The addition of more oxygen to it, after this combinati has been attempted in vain, cauſes it to cryſtallize in ſm [illegible] needles.

SEC

SECTION TWENTY FIFTH.

OF SEBACE, AND ITS IMMEDIATE COMPOUNDS.

BOOK V.
SE. XXV.

1.
Origin of
SEBACE.

It is well known that both animal bodies and even the vegetable kingdom, afford in abundance, a ſubſtance diſtinguiſhed by the name of FAT. This ſubſtance yields by diſtillation a peculiar acid, to which has been given the name of the SEBACIC ACID. The compound baſe of this acid, may be denominated SEBACE. There is alſo another proceſs for procuring the acid, in which lime is employed in a complex and lengthened proceſs of ſolution, evaporation, filtration, calcination, that at laſt gives the SEBACIC ACID in ſufficient purity.

2.
Nature of
the SEBACIC
ACID.

This acid, thus obtained, is liquid, fuming, of a penetrating ſmell, decompoſable by fire. The action of fire, produces from it hydrogen, carbonic acid gas, and azote in [illegible] proportions. Its colour is white. Its taſte is pungent. With the earths and alkalis, it forms cryſtallizable and fixed neutral ſalts. Blue colours are ſtrongly reddened by it. Water diſſolves it in all proportions.

SECT.

SECTION TWENTY SIXTH.

OF LITHE, AND ITS IMMEDIATE COMPOUNDS.

BOOK V. SE. XXVI.

1. Origin of LITHE.

THAT the *ſtone* found, in diſeaſe, *in the* human *bla*
contains a peculiar acid ſubſtance, is a diſcovery for w
we are indebted to the great Swediſh chemiſt, SCHE
This matter forming the *ſtone* or *calculus*, is to be foun
all urine. It is by an undue retention of the calcu
matter, that the ſtony concretion comes to be forme
the bladder. The compound baſe of this acid, may be
nominated LITHE.

2. Nature of the LITHIC ACID.

The LITHIC ACID is—dry; cryſtallized in flat need
almoſt inſipid and inſoluble; in part, volatile; decom
able by intenſe heat; ſubject to afford upon its decomp
tion by fire, an ammoniacal carbonate, and pruſſic a
With the nitric acid, it forms a beautiful red ſoluti
and is entirely diſſolved with the diſengagement of nitr
gas and carbonic acid. It forms peculiar neutral ſalts w
the earths and alkalis.

Sp. XXVII.

1\.
Origin and nature of BOMBE and the BOMBIC ACID.

[illegible] its [illegible]. This acid [illegible] of the academy of Dijon, [illegible] the juice of the chryſalis through a cloth, [illegible] the mucilage with alcohol; and by infuſing [illegible] in alcohol. The baſe of this acid may be [illegible]; and is, no doubt, a compound. The BOM[illegible]pears in a liquid form; is of an amber yellow [illegible]ble to ſpontaneous decompoſition; and affords [illegible], when diſtilled, or treated with nitric acid. [illegible] are little known.

[illegible]ALLIC ACIDS are, for an obvious reaſon, re[illegible] treated of in their proper place, among the

SECT.

SECTION TWENTY EIGHTH.

RECAPITULATION OF THE PRINCIPAL FACTS IN THE GENERAL CHARACTER OF THE ACIDS.

BOOK V. S.XXVIII.

1. Review of the general qualities of the acids, propoſed.

WE have now enumerated and deſcribed in particular detail, all the known Acidifiable Bases. Although theſe be not all elementary and ſimple ſubſtances; yet there is among them ſo ſtrong an analogy in a great variety of different reſpects; that we were unavoidably led to conſider the compound acidifiable baſes in the ſame ſeries with thoſe which are ſtill regarded as ſimple. The Acids are almoſt the only immediate compounds of theſe different acidifiable baſes, which we have, as yet, had occaſion to examine. But, the Acids hold a ſignally eminent place among the ſubjects of chemical art and ſcience. It may be proper, ere we conclude this book, yet to review the leading facts in the general character of theſe remarkable ſubſtances.

2. Diſcovery of their compound nature.

I. The firſt fact that ſtrikes our notice, while we enter upon this review, is, that theſe acids which chemiſtry not long ſince *ſuppoſed to be all* SIMPLE ſubſtances: Have been, by the diſcoveries of Lavoiſier, aſcertained to be, in all but the three inſtances of the muriatic, the fluoric, and the boracic acids, undeniably COMPOUNDS. Even in theſe three inſtances, analogy, nay, in the caſe of the oxygenated muriatic acid, more than analogy, leads us to infer a nature ſimilarly compound, although we have not yet been able to ſeparate the component principles from one another. The knowledge which the modern chemical diſcoveries have conferred, of the compound nature of the

acids

cids,—carries us into a deeper inſight into the ſecrets of ture; renders chemiſtry more *philoſophical* by unfolding to the ſpeculative chemiſt's view, a much wider concatenation of cauſes and effects, than he could before diſcern; and confers new powers upon the art of the practical chemiſt, by enabling him to procure the ACIDS by many new thods, of the bare poſſibility of which he was, before, norant.

3. Their ſour taſte, and power to redden blue vegetable colours.

II. The next thing particularly worthy of our obſervation, is, that, theſe ACIDS all agree in two or three obvious and ſimple properties, beſide that of their recently diſcovered compound character. They all communicate a RED TINGE *to blue vegetable colours*, and affect the organs of taſte with that ſenſation which is called SOUR. Theſe are the qualities which in all the ſtages of the progreſs of chemical ſcience, procured ſuch of the acids as were known, to be ranked in one general claſs. Theſe are properties diſcernible by the vulgar, no leſs than by the philoſophical chemiſt. Scarcely any two of the acids, indeed, agree ſo far as to poſſeſs theſe properties preciſely in the ſame degree. But, the different ſhades of variation which diſcriminate theſe properties from one another in different acids, ſerve but to mark inferior genera, ſpecies, or varieties, not to conſtitute widely diſagreeing claſſes.

4. They enter into the compoſition of neutral ſalts.

III. Another general property of theſe acids, which indeed has not hitherto forced itſelf particularly upon our attention, is that of forming by combination with the earths, alkalis, and metals, that multitude of ſubſtances which are known by the name of NEUTRAL SALTS. When we ſhall have conſidered the very extenſive number of theſe ſubſtances; and ſhall reflect, how little thoſe who firſt attempted ſcientific chemiſtry could know of their

mutual

mutual relations; we ſhall no longer wonder at th
dity of thoſe theories, at the unmeaning intricacy
diouſneſs of thoſe proceſſes, at the wildneſs of th
dreams of imagination, which appear in the writing
more ancient chemiſts. To them, the chemical
muſt have appeared a chaos in which an endleſs m
of unallied ſubſtances were confounded together;
they were ſo utterly unpractiſed in it, that thei
could not yet give them juſt notions of the diſtan
colours, the relative magnitudes of the forms befor

5. They are all acidified by oxygen.

IV They agree alſo in owing, all, their acidifi
the ſame common principle, OXYGEN. The exiſtenc
principle is the diſcovery of LAVOISIER. Its preſence h
ſatisfactorily traced by analyſis in all but the three a
unknown baſes. In theſe, it may be fairly inferre
the analogy of their other qualities. As far as an
fiable baſe requires OXYGEN to its complete, primary
tion; ſo far does the addition of this ſubſtance app
to increaſe the ſtrength of the qualities of the acid.
in the caſes of ſuperſaturation, the addition of ox
ſometimes rather unfavourable to the force of the p
ly acid qualities of the acid. The diſengagement o
GEN by combuſtion; its exiſtence in water, in vital
all burnt bodies not yet reſtored to their former ſt
continual evolution or fixation in many of the gre
ceſſes of nature; open to us new views of the relati
the ordinary natural origin of acids, as well as of th
and the ſecret operations of nature.

6. The baſes of many of them are compounds of hydrogen, carbon, and azote.

V. The diſcovery of the compoſition of the baſe
many of thoſe ACIDS which we obtain chiefly from t
mal and the vegetable kingdoms; has alſo cont
mightily to render our ideas of the origin of c

tartareous, the oxalic, the camphoric, the
the pyromucous, the pyroligneous, the
ids; TWELVE in number; have baſes which ap-
be compounded of hydrogen and carbon. The
ic, the fluoric, the boracic acids have, in combina-
oxygen, baſes of which we know not yet the ul-
ture; whether they be compound or ſimple; or
they may be entirely ſeparated from the acidify-
ciple. The ſulphuric, the ſulphureous, the nitric,
tous, the carbonic, the phoſphoric, the phoſpho-
and three metallic acids which we are hereafter to
have baſes which we have obtained ſeparate,
to be ſimple ſubſtances. As it is from the ana-
the decompoſable acids, that we conclude thoſe
have not yet been able to decompoſe, to be aci-
oxigen: So from the analogy of thoſe of which
are known to be compounds, we may perhaps
infer, the poſſibility of thoſe baſes being hereaf-
poſed, which are now imagined to be ſimple. It
poſſible but chemiſts may yet diſcover all the acid
but ſo many compounds of azote, carbon, and
in different proportions and modifications. Per-
carbon may be at length decompoſed. This

very of the compound nature of the acids, of water,
of the gaſes; they will be induced to conſider this po
diſcovery of the compoſition of the acid baſes, as pre
alſo with the moſt important benefits to mankind;
will not fail to purſue with ardour an object of ſuch
reſting magnitude. The *animal* and *vegetable* acids
obtained with greater difficulty, and through pro
much more complex, than thoſe others which are uſ
denominated the *mineral acids*; are, in the courſe of
proceſſes neceſſarily ſubjected to a greater variety of
influences as might be ſuppoſed naturally capable of
geſting to us the means of analyſing them. Natur
pears to employ finer, more delicate, and more com
proceſſes, in producing, ſuſtaining, and diſſolving an
and vegetable bodies, than are neceſſary to be employ
accompliſhing thoſe changes to which the parts of i
mate nature are ſubject: And hence is it, perhaps, th
animal and vegetable matters we find ſubſtances in a ſt
decompoſition, which, if we had viewed them only i
air, the earth, or ſeas, we ſhould have thought inc
of being farther ſimplified.

7. Remarkable wiſdom and power are diſplayed in the laws and relations of the acids.

VI. It is impoſſible to remark theſe general fac
cerning ACIDS and their elements, without being
reflect, that the wiſdom and the awful power of t
thor of nature, are more intereſtingly and more
ingly illuſtrated by chemiſtry, than perhaps by any
of the phænomena of nature which vulgar or even
ſophical curioſity has yet obſerved. We now ſee
cy, a fineneſs, an elegance, a wonderful artifice in
ſeſt, and, at a careleſs view, the moſt unintereſting
changes on the material world, ſuch as are not
thoſe to which we had excluſively referred all be
limity, and order.

El

EMENTS OF CHEMISTRY.

BOOK SIXTH.

E EARTHS, THE ALKALIS, AND THEIR NEUTRAL COMPOUNDS.

SECTION FIRST.

OF SILICE AND ITS COMPOUNDS.

1.
Earths and alkalis enumerated.

ſimple ſubſtances capable of forming, by their mutual combinations, thoſe compounds which are named ; we now proceed to another claſs of natural bodies, are alſo for the moſt part ſimple; and which enter-to combination with the acids, thus form thoſe new ounds which are diſtinguiſhed as Neutral Salts. bodies are commonly called earths and alkalis. are *Silice*, *Alumin*, *Baryt*, *Lime*, *Magneſia*, *Potaſh*, *mmoniac*,—beſide *Strontite*, and ſome others of which plicity may be more queſtionable.

2.
Diſtinctive properties of the earths.

e earths are diſtinguiſhed from the alkalis, chiefly as ſuſceptible of lapideous aggregation, as being nearly gether inſipid to the taſte, as being naturally dry, ng leſs regularly ſubject than concrete acids and alkalis, ſtinct and always diſcernible cryſtallization.

SILICE is the firſt of theſe terrene ſubſtances, whic ſhall conſider. This earth is rough to the touch; ſc es and wears down metals; is infuſible and incombuſt is inſoluble in water, and in all acids, except the fl and perhaps the ſebacic; is ſoluble by alkalis, when ex in contact with them, to the action of an intenſe forms, in conſequence of this ſolution, a well known This earth has never yet been either decompoſed tated.

3. Nature of SILICE.

SILICE enters into the compoſition of very those ſtones which fall to be examined by the mi Quartz, flint, agate, jaſper, grit-ſtone, and all ſci ſtones, have SILICE for their baſe, and accordingly in great abundance. It is often broken down into the channels of rivers, and on the ſea-ſhore. It ſcattered in a powder in the ſoil which forms the rior ſtrata of the earth. It is applied in art to a tude of uſes. Glaſs, cements, porcelain are manuf of ſiliceous earth reduced by alkalis to a running Mill-ſtones are cut out of rocks which have SILI their baſe.

4. Where it is found in nature.

We know, however, of no neutral ſalts into the ſition of which SILICE enters properly as a baſe. compounds which may ſeem to be produced betw LICE and the fluoric acid, are rather mixtures than nations. The earth is merely ſuſpended in the

5. Its neutral compounds unknown.

SECTION SECOND.

OF ALUMIN, AND ITS COMPOUNDS.

1.
Nature of pure ALUMIN.

E **ALUMIN** is ſoft to the touch of the finger; adheres
tongue; hardens in the fire; forms a paſte with
. It is ſuſceptible of combination with moſt acids.
es into flakes. Mixed with water and *ſilice*, it aſſumes,
e mixture, extraordinary hardneſs. It is contained in
ge proportion in common clays, in pipe-earth, in ſchiſ-
in ſteatites, and in a great diverſity of ſtones. In
of the arts, it is uſed, as a ſubſtance adapted to
e and retain any artificial form, which may be baked
e fire, and which is fitted to reſiſt the penetration of
. Its intricate nature, or component principles, are
wn. It has been by ſome regarded as *ſilice* altered,
d, and moulded down by the action of air and water.

2.
Number of its neutral compounds.

the acids, it is known to form more than twenty
of NEUTRAL SALTS. All theſe ſpecies have a ſour
gent taſte.

The firſt of theſe ſpecies of the neutral ſalts, formed
combination of ALUMIN with the *acids*, is *Aluminous*
its, *Sulphate of Alumin*, or *Alum*.

3.
Qualities and hiſtory of SULPHATE of ALUMIN.

is neutral ſalt is formed by the combination of ALU-
ith *ſulphuric acid*. Applied to the tongue, this ſalt
the organs with a taſte that is, at firſt, ſweetiſh, but
wards felt to be ſtrongly aſtringent. It reddens blue
; a fact which ſhews it to contain ſtill a portion of the
unſaturated with alumin. It is capable of a regular,
lized form. Nature rarely preſents it pure. Mine-

ralogiſts

reduced to ſmall pieces, over the floors of the mbers in which the work is carried on,—to ap- in this ſtate, ſulphuric acid gas, obtained by ſtion of ſulphur with ſalt-petre,—then to await of the acid upon the clay, which is in this caſe erful than if the acid had been diluted in water. mmon operations of this manufacture, in which ſalt is extracted from pyritical earths and ſtones, ced to this form;—the decompoſition of the mine- ually in the open air, or elſe by fire;—the lixivia- roduct obtained by theſe proceſſes;—the eva- the lixivium in leaden cauldrons to the point ;—the refrigeration of the concentrated lixi- ers, till be fixed in tetrahædral pyramids, join- , by two and two, at the baſes. Alum manu- y the direct combination of the ſulphuric acid is always more or leſs impregnated with iron.

5. More particular deſcription of its form and qualities.

s SULPHATE, in a regular cryſtalline form, is hædron, conſiſting of two tetrahædral pyra- ſes of which are united. A gentle heat lique- causing a good deal of aqueous vapours then to t. The alum then ſwells into a large, light , and full of cavities over all its ſurface. Un- ation it has loſt half its weight. Diſſolved in rds a precipitate of a ſmall portion of earth. rature of 60°, SULPHATE OF ALUM is ſoluble weight of water. At higher temperatures, r proportion of water will be ſufficient. In , it is called *calcined alum*; and it may be former condition by reſtoring the water of which hath been expelled out of it.

6. Re-action of SILICE upon it.

no diſcernible alteration on SULPHATE OF

United with a larger proportion of ALUMIN than it
dinarily contains, this ALUMINOUS SULPHATE will aſſume
characteriſtic properties of common clay. To ſuperſatu
alum with ALUMIN, boil a ſolution of the ſalt with a
tion of the pure earth. The mixture, under this
will loſe its ſtiptic taſte. Evaporated, this mixture
ſplangles of a micaceous appearance. A lixivium of
mixture, yielded within a few months, by expoſure
the air, very regular, cubic cryſtals. Alum once ſatu
with ALUMIN, can never again be reduced to the
pure alum.

7. Its ſuper-ſaturation with ALUMIN.

8. Super-ſaturated ſolution of alumin in *ſulphuric acid.*

The *ſulphuric acid* eaſily diſſolves ALUMIN, in
the compoſition of this ſalt, only when the ALUMIN i
and wet. When the ALUMIN is dry, the ſolution
not take place, without conſiderable difficulty.

9. Compoſition of the ALUMINOUS PYROPHORUS.

SULPHATE OF ALUMIN, if expoſed to fire with com
ble matters, forms a ſubſtance which kindles to flam
the air, and is called *Homberg's pyrophorus.* The pro
tion of this matter, was the reſult of a long ſeries of
riments, by which Homberg hoped to obtain from the
man fæces, a white oil that ſhould fix mercury into
ſilver. It has ſince been aſcertained, that this pyro
rus may be formed with alum, from various animal
vegetable ſubſtances, and even from moſt ſalts w
contain ſulphuric acid. *Le Jay de Suvigny* has ſug
ed, that this pyrophorus probably contains *glacial*
vitriol; and that this oil attracting moiſture from th
moſphere, and gradually heating the maſs, kindles th
phur and occaſions a ſpontaneous evaporation. The
phorus is uſually prepared by melting three parts of
with one part of ſugar, honey, or meal, in an iron-
The mixture is dried till it becomes blackiſh, and ce

ell. It is then broken in pieces, and put into a mattraſs r phial luted with earth. This veſſel is to be put into a cible containing ſand; and heat muſt be applied till a eiſh flame be ſeen to iſſue from the mouth of the phial. ter it has been ſeen to burn for a few moments, the cible is removed from the fire. Its contents are left to ol; and the pyrophorus is then to be poured into a y flaſk very cloſely ſtopped. Thus prepared, the pyrorus may be preſerved, to be at any time kindled by exſure to the atmoſphere. Humid vapour, when preſent, s found to hinder the inflammation of this pyrophorus. M. hourt, in a ſeries of recent experiments communicated to e world in the *Journal de Medicine* for the year 1778, has diſvered that all ſubſtances containing an intermixture of carn with an earth or metallic oxyde, and ſubject to leave upn diſtillation, a reſidue of theſe matters, may be brought to ontaneous inflammation in the air. Mr Bewly in a letr, addreſſed to Dr Prieſtley, aſcribes the inflammation of rophorus, to its containing a ſubſtance capable of attracg nitric acid from the atmoſphere. In the *Journal de hyſique* for November 1780, it is ſuggeſted that the comſtion of this pyrophorus, is owing to its containing alys a proportion of phoſphorus.

10. New theory of the combuſtion of pyrophori.

These theories of the combuſtibility of pyrophori have en ſatisfaction to no philoſophical chemiſts. A rational count of the relations upon which it depends, is ſtill wantd. The following is the reſult of my experiments, obſervans, and reflections upon this ſubject. *PYROPHORI burn in the air by ſpontaneous inflammation; becauſe they contain a MIXTURE of theſe COMBUSTIBLE MATTERS which are the eaſiſt brought into ordinary combuſtion—with other ſubſtances conining in a looſe ſtate of combination, that OXYGEN which muſt*

in

tic, and extremely liable to deliquiate. Theſe are dec ſable by the ſame ſubſtances which decompoſe ſulph alumin. This ſalt has not yet been found in nature ; always a product of art.

13. Muriate of alumin.

III. MURIATE OF ALUMIN, is the third of the ſpe neutral ſalts, into the compoſition of which this ea known to enter. The ſolution of ALUMIN in *muriati* when the ſubſtances are mutually ſaturated, is gelati and not ſuſceptible of being filtered, unleſs it be very l ly diluted in water. Its taſte is ſtiptic and ſaline. It reddens ſyrup of violets ; and then converts the red c to a green. By ſpontaneous evaporation, it affords l ſtiptic cryſtals, of which the form has not yet been ex ed, and which are decompoſable by lime-water. Mur OF ALUMIN is apt to deliquiate. Its other propertie unknown. It has never yet been obtained, but by th nipulations of art.

14. Borate of alumin.

IV. BORATE OF ALUMIN is a neutral ſalt which ha yet been particularly examined. A ſolution of *borate da*, poured into a ſolution of ſulphate of alumin, prod light, flaky precipitate : And amid the changes which take place, the earth combines with the *boracic acid.* borate may be decompoſed in the ſame manner as com alum.

15. Fluate of alumin.

V. FLUATE OF ALUMIN, the fifth of thoſe neutra which have ALUMIN for their baſe, is a ſalt artificially f ed, and of a gelatinous conſiſtency.

16. Carbonate of alumin.

VI. CARBONATE OF ALUMIN has been, as yet, but little examined. But, when a ſolution of ALUMIN i cipitated by the alkaline carbonates ; the filtrated li after ſome time, depoſites a little earth which was h ſolution by the carbonic acid, and is now left in a ſe ate by the gradual eſcape of the acid. When the matters re cold, this precipitation takes place, without any efferveſcence ; and a part of the carbonic acid ſeparated by the alkali, appears to enter into combination with the ALUMIN, while another part is diſſolved in the liquor. It ſhould ſeem, that CARBONATE OF ALUMIN is not unfrequently to be met with in nature ; for, there are different argillaceous earths which when diſſolved in ſulphuric or muriatic acid, never fail to efferveſce. Beſides, *lac lunæ* is certainly a CARBONATE OF ALUMIN.

17. Other aluminous ſalts.

VII. SUCCINATE OF ALUMIN, is a neutral ſalt in cryſtals, formed by the combination of alumin with the ſuccinic acid.

VIII. ACETITE OF ALUMIN, is the neutral ſalt formed by the union of this earth with the acetous acid : And is, by ſome chemiſts, repreſented as a whitiſh, non-cryſtallizable maſs, eaſily formed, in conſiderable quantity; by others, as a combination which takes place but ſparingly, and exhibits itſelf in ſmall needled cryſtals.

IX. TARTARITE OF ALUMIN, the neutral ſalt produced by alumin brought into union with tartareous acid, is by the evaporation of the acid ſolution, obtained in a non-deliqueſcent ſubſtance of a clear, gummy conſiſtency.

X. PYRO-TARTARITE OF ALUMIN, is a neutral ſalt which has not yet been examined.

XI. OXALATE OF ALUMIN, is obtained by diſſolving this earth with oxalic acid. The liquor, if evaporated, affords a deliqueſcent maſs.

XII. GALLATE OF ALUMIN, is as yet unknown.

XIII. CITRATE OF ALUMIN, is a neutral ſalt, not yet particularly known.

XIV. MALATE OF ALUMIN, is a neutral ſalt formed by the combination of alumin with the malic acid, and not eaſily ſoluble.

XV. Benzoate of alumin, is a neutral ſalt that ha been, as yet, but little examined.

XVI. Of pyro-lignite of alumin, the properties have not yet been minutely enquired into.

XVII. Pyro-mucite of alumin, is a neutral ſalt formed by the union of aluminous earth with that pyro-muco acid, which we obtain by the diſtillation of mucilages, a the rectification of the product with clay. Its propert are little known.

XVIII. Camphorate of alumin, is unknown.

XIX. Lactate of alumin, is a deliqueſcent neu ſalt, the reſult of the combination of aluminous earth w the lactic acid.

XX. Saccho-lactate of alumin, is a neutral ſalt in luble in water, which we obtain by combining alumin earth with the acid of ſugar of milk.

XXI. Formiate of alumin, is a peculiar compo formed by combining aluminous earth with formic acid.

XXII. Pruſsiate of alumin, is unknown.

XXIII. Sebate of alumin, is equally unknown.

XXIV. Lithriate of alumin, is alſo unknown.

XXV. Bombiate of alumin, is an unknown ſalt.

XXVI. Cortate of alumin, is a deliqueſcent neu ſalt formed by the union of alumin with the cortic aci acid of cork.

XXVII. Phosphate of alumin, is the neutral ſal ſulting from that combination of alumin with phoſph acid, which is readily effected in the dry way.

So much for this ſimple earth, and for thoſe neutral which are in part, compounded of it.

SECTION THIRD.

OF BARYT, AND ITS COMPOUNDS.

1.
In what ſtate BARYT exiſts in nature.

YT has acquired its name from its extraordinary ſpe-
gravity. It was firſt diſcovered by the Swediſh che-
GAHN, SCHEELE, and BERGMAN. Its ſpecific gra-
s, according to KIRWAN, ſomewhat more than 4,000,
is, it is ſomewhat more than four times as heavy as an
l meaſure of water. Nature preſents it in conſiderable
dance; no where, pure; always in combination with
, or in admixture with other earths. Its properties in
re ſolitary ſtate, have been, as yet, much leſs ſtudied,
the qualities of its compounds. Its chemical attrac-
, and the ſalts which it forms by combination with a-
are very remarkable.

2.
More particular account of its qualities.

re BARYT obtained, by a proper proceſs, from its na-
l compounds, appears in a pulverulent form, very fine
white. It does not affect the tongue with any diſcerni-
taſte. Whether or not it be alterable by light, is not
known. If heated in a crucible of clay, it will commu-
te to the crucible, a blue or greeniſh colour; aſſuming
f a ſlighter tinge of the ſame. This phænomenon may
from its power of reaction upon alumin. M. D'AR-
ſays, that it is fuſible by a very violent heat: M. LA-
fuſed BARYT in a few ſeconds, by a flame fed with
oxygen. Yet, in both theſe caſes, the BARYT uſed,
perhaps have been more or leſs impure: for the Swediſh
iſts have declared it to be wholly infuſible. By expoſure
e air, BARYT ſlowly gains a ſmall acceſſion of weight.
Parts of water diſſolve 1 part of BARYT: and the wa-
ter

ter which is thus ſaturated, gives a pale green colour to the tincture of violets, mallows, or radiſhes. The ſolution, if expoſed to the air, is covered with a thin pellicle; and after the removal of this pellicle, by another. Evaporated in cloſe veſſels, the ſolution affords a reſidue of BARYT. This earth acts, either in the humid or the dry way, but very feebly, upon *Silice*, or *Alumin*. It, however, facilitates the fuſion of theſe earths. By ſome modern chemiſts, BARYT is ſuppoſed to be a compound ſubſtance, and actually a metallic oxyde. Its intimate nature is however, unknown. M. FOURCROY ſuſpects it to be a compound of gas-azote with ſome other ſubſtance. Solutions of BARYT in water and in acids, are uſed as re-agents. It is not, in its pure ſtate, applied to any other uſes.

3. eutral lts form- l with it.

BARYT forms by its combinations with acids, the following ſpecies of NEUTRAL SALTS, which ſhall be here ſucceſſively examined.

4. rigin of LPHATE BARYT.

I. SULPHATE OF BARYT is named alſo ponderous ſpar. It is rather a product of nature, than a compound of art. It is almoſt always found with metallic ores. It appears either in cryſtals or in ſhapeleſs maſſes, but always in ſtrata of various extent and thickneſs. Six principal varieties of it have been particularly enumerated and deſcribed. It is ſometimes cryſtallized in ſix-ſided priſms, terminating in dihædral ſummits; two of the ſides being very large, four very ſmall: Theſe cryſtals are diſpoſed in a oblique poſture, and are often covered with yellowiſh rhomboidal cryſtals. They have the appearance of oblong ſquare plates, of which the ſides have been cut aſlant. Sometimes theſe plates have not their ſides cut obliquely; are not regularly cryſtallized; are incruſted with a red pyritical or ſilvery matter. In other inſtances, this native SULPHATE OF

BOOK VI.
SECT. III.

T appears in converging filaments united into laminæ,
h are arranged, one over another: And of this ſort,
e well known phoſphoric variety of *Bologna Stone*. It
ars alſo in octohædral cryſtals like thoſe of alum; hav-
he ſummits of the pyramids, often truncated ſo as to
a decahædral figure. Sometimes it exhibits a duo-
hædral cryſtallization, like that of certain garnets, and
pyritous ſtones. There is alſo a pyramidal variety of
SULPHATE OF BARYT. But, it muſt be confeſſed, that
repreſentations of chemical mineralogiſts are ſo diſcor-
t, as to ſhew that they are, as yet, but very imperfectly
uainted with the native varieties of this ſalt. That va-
which is diſtinguiſhed by the appellation of the *Bolog-*
ne has long been particularly noticed for its quality of
ing a lively blueiſh light in the dark, after having been
while heated in the fire. But all the varieties of BARY-
LPHATE, are now known to poſſeſs the ſame pro-

5.
Proceſs for forming the BOLOGNA STONE.

PHATE OF BARYT is uſually prepared by the follow-
ceſs, for exhibiting in the dark the illumination of
gna ſtone. It is made red-hot in a crucible, is beaten
rtar to a powder, is formed into a paſte with gum
th, and is then divided into cakes of the thickneſs
ade of a knife. Theſe cakes are then expoſed to
lcination in a furnace; the aſhes are blown off
ir of bellows; the cakes are ſubjected for a few
the action of the light; and after this, they may
ed to ſhine in the dark, and even in water, like
coal. But, this *abſorption of light, without fixing*
ent combination, is common to theſe with many
ances. BARYTIC SULPHATE ſuffers no laſting
the action of *caloric* upon it.

In water this ſalt is abſolutely inſoluble. The
and the ſalino-terrene matters have no power of ac
on it. The mineral acids accompliſh no alteratio
it. Carbon, mixed with this ſalt in the proportion
part to eight; expoſed with it in this ſtate for the
two or three hours to the action of a ſtrong hea
then poured into diſtilled water; will immediately a
laſt event, communicate to the fluid, a yellow colo
all the qualities of a ſolution of an earthy *ſulphure*,
of a mixture of ſulphur with earth, without the in
tion of an acid. This ſulphur is formed by the ca
tracting away under the influence of the furna
that oxygen by which the ſulphur was acidified in t
PHATE OF BARYT in the mixture. The proceſs
contained by the intermediation of other ſalts, till
at laſt afford the pure BARYTIC EARTH in a ſepara
There is another proceſs for the decompoſition
PHATE OF BARYT, which ſhall be hereafter deſcribe
to the uſes of BARYTIC SULPHATE in the arts: ph
cakes are prepared from it; and the BARYT which
tains, is extracted for the uſe of the chemical labora

6. Relations of SULPHATE OF BARYT to other ſubſtances.

7. NITRATE OF BARYT.

II. NITRATE OF BARYT has been formed by th
combination of BARYT with *nitric acid*. The reſult
combination is a neutral ſalt, which we with great d
obtain in large hexagonal cryſtals, or according
D'Arcet in ſmall irregular cryſtals. This ſalt is dec
ble by *fire*, which makes it to evolve gas-oxygen.
tracts the moiſture of the atmoſphere; yet requires
proportion of water to maintain it in ſolution. Su
acid poured into a ſolution of BARYTIC NITRATE,
from it a precipitate of *barytic ſulphate*. The
too, robs this neutral ſalt of its baſe. Neither

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the other earths, nor the alkalis, decompoſe this ſalt. Its properties and relations are ſtill but imperfectly known.

8.
MURIATE OF BARYT.

III. MURIATE OF BARYT is a neutral ſalt which may be obtained in oblong ſquare tables, reſembling thoſe of *ponderous ſpar in tables*. It is not eaſily ſoluble; ſuffers no alteration from ſilice, alumin, magneſia, or the alkalis. The ſulphuric and the fluoric acids decompoſe this ſalt, and combine with its baſe. By means of this ſalt, any portion, however ſmall, of ſulphuric acid, may be detected in any mineral water. All ſulphuric ſalts are liable to be decompoſed by the preſence of even a few drops of a ſolution of this ſalt; which forms by the ſolution, *ſulphate of baryt*, in white ſtriated cryſtals. The attraction between *ſulphuric acid* and BARYT is the ſtrongeſt of all the attractions to which the acid is ſubject.

9.
BORATE OF BARYT.

IV. BORATE OF BARYT is a ſalt hitherto unexamined. GMAN accounts the attractions between BARYT and *bo- ic acid* to be the weakeſt of all the attractions to which is earth is ſubject.

10.
FLUATE OF BARYT.

V. FLUATE OF BARYT is alſo but little known. BERG- an, indeed, relates, that *fluoric acid*, if poured into a ſolu- n of *barytic nitrate* or *muriate*, occaſions a precipitation; d the precipitate thus produced, effervеſces with the ſul- ric acid, which expels from it, the fluoric. The fluoric d, therefore, muſt form with BARYT, a ſalt leſs ſoluble n either *barytic nitrate* or *barytic muriate*.

11.
CARBONATE OF BARYT.

VI. CARBONATE OF BARYT is a ſalt which poſſeſſes ſome gular properties, and ſeems to bear a reſemblance to mon chalk. BARYTIC CARBONATE has been found in re, on Alſton-Moor in Cumberland, in the lead-mines Anglefark near Chorley in Lancaſhire, in Argyleſhire, hlangenberg in Siberia, and in the pit of Iſaacfund near Freyberg in Saxony. We produce it artificial decompoſing with alkaline carbonates, any of the barytic neutral ſalts. The new BARYTIC CARBONATE dually forms a pellicle on the ſurface of the ſolution; will be found to efferveſce with acids, preciſely in the manner as the pellicle which is formed upon the ſolu of lime. Expoſed to the action of fire, this CARBONATE BARYT, gives out it's acid, in its natural gazeous form. very intenſe heat is, however, requiſite to expel the entirely. All thoſe acids which are ſuppoſed peculiar mineral kingdom of nature, decompoſe this ſalt, and engage the carbonic acid. A lively efferveſcence al accompanies this change. BERGMAN reckons that 100 of CARBONATE OF BARYT, contain 27 parts of carbonic gas, 65 of BARYT, and 8 of water. *Water*, if pure, ſcarce diſſolve this ſalt; but when impregnated with bonic acid, diſſolves it in the proportion of 1 to 1550 By this, indeed, it ſhould ſeem that CARBONATE OF BA is leſs eaſy of ſolution than pure BARYT; for BERGMAN that water diſſolves pure BARYT in the proportion of 900. BARYTIC CARBONATE has not been applied to uſe in medicine or in the arts.

VII. PHOSPHATE OF BARYT is a neutral ſalt, of the properties are, as yet, but imperfectly known.

VIII. SUCCINATE OF BARYT is a ſalt of very difficult lubility.

IX. ACETITE OF BARYT preſents itſelf in a ſaline unſuſceptible of cryſtallization; and, when dry, apt tract moiſture from the atmoſphere.

X. TARTARITE OF BARYT is a ſalt but little know

XI. PYRO-TARTARITE OF BARYT has not, as yet, much examined.

XII. Oxalate of baryt, is a ſalt ſcarcely ſoluble, unleſs with exceſs of acid. With exceſs of the acid, this ſalt affords cryſtals, which, when that exceſs is taken up by boiling water, become opake, pulverulent, and inſoluble.

XIII. Gallate of baryt is a ſoluble ſalt, which has not, as yet, been very attentively examined.

XIV. Citrate of baryt, the combination of citric acid with this earth, has not yet been examined.

XV. Malate of baryt is as yet unknown.

XVI. Benzoate of baryt is alſo unknown.

XVII. Pyro-lignite of baryt has not been examined.

XVIII. Pyro-mucite of baryt is a compound of unknown qualities.

XIX. Camphorate of baryt is unknown.

XX. Lactate of baryt is a deliqueſcent ſalt.

XXI. Saccho-lactate of baryt is believed to be inſoluble in water.

XXII. Formiate of baryt is unknown.

XXIII. Pruſſiate of baryt is as yet unknown.

XXIV. Sebate of baryt is unknown.

XXV. Lithiate of baryt is unknown.

XXVI. Bombiate of baryt is equally unknown.

XXVII. Cortate of baryt is probably a deliqueſcent ſalt.

Such are the moſt remarkable facts concerning baryt and its compounds.

SECTION FOURTH.

OF LIME, AND ITS COMPOUNDS.

OK VI.
CT. IV.

I.
gin and
ure of

LIME is a white ſubſtance of conſiderable aggregate conſiſtency. It is in the form of a grey-white ſtone. Its taſte is hot, acrid, urinous. Applied to the ſkin, it produces a degree of inflammation. Its common form in its pure ſtate, is pulverulent and friable. It is found in places contiguous to volcanoes, as for inſtance, on the hills of Auvergne in France. It turns ſyrup of violets to a green colour much darker than that communicated by either baryt or *magneſia*: a dirty yellow indeed, in a ſhort time ſucceeds the original colour. In a ſolitary ſtate, LIME is incapable of fuſion. On a ſupport of *charcoal*, it ſeems to have been brought by Parker's lens to the commencement of fuſion: And in a *clay* crucible, its edges ſometimes appear to melt. The *moiſture* of the atmoſphere makes it gradually ſwell, break, and fall down in a powder. This *dry-ſlaking*, as it is called, produces an evolution of *caloric*; and is attended with a dilatation of the LIME, ſufficient to burſt thoſe caſks or other wooden veſſels in which it may be contained. LIME which has been thus ſlaked, affords water, when it is made red-hot in a retort. *Water* brought, in its liquid ſtate, into contact with LIME, acts upon it very powerfully. A ſtrong heat is excited around the point of re-action: a remakable hiſſing is heard: at leaſt a part of the water is reduced to a vapour of a peculiar ſmell, which gives a green colour to paper tinged with mallows: the LIME is quickly reduced to a powder: and the heat, motion, and ſmoke gradually diſappear.

r. The LIME thus ſlaked certainly contains water, or ſt one of the principles of water in a concrete form. mixed with water in the proportion of 1 to 680 is tained in a perfect ſolution, ſuch as is known by the llation of *lime-water*, at the temperature of 60°. This ion is but very little heavier than common water, has rid urinous taſte, communicates a deep-green colour to p of violets; and even permanently alters the original r of this matter. Evaporation affords the water ; and leaves the LIME in a reſidue. Expoſure to the n air occaſions the gradual formation of a pellicle of *ate of lime*, upon any quantity of lime-water contained veſſel. Both in the humid and in the dry way, is ſuſceptible of union with ſilice. This mixture, which bject to many varieties; affords what is well-known r the appellation of mortar. Alumin in certain ſtates, indeed be uſed to form a *mortar* with LIME, juſt as as *ſilice*. LIME and ſilice, although both infuſible ſe-ly, may, however, be brought into fuſion, if they be together, as has been obſerved by Meſſrs D'Arcet Gerhard. But a mixture of ſilice, alumin, and lime, ree together, melts yet more eaſily, and more com-ly. LIME is generally believed to be in its origin, a ation from the organic functions of marine animals. is perhaps, if it be a compound, one of its conſtituent ples. In hot water LIME is $\frac{1}{2}$ more ſoluble than in of the common temperature of 60° Fahrenheit. uſand parts of LIME are capable of diſſolving at the f 60° Fahrenheit, 228 parts of water. The ſpecific y of LIME is to that of water as 2720 to 1000. In cture for the compoſition of mortar; in medicine, in caſes of ulcer, &c. ; in agriculture, as a manure ; is very much uſed.

2. It forms NEUTRAL SALTS.

The *neutral ſalts* into whoſe compoſition LIME ent a principle, are theſe ; ſulphate of lime, nitrate of muriate of lime, borate of lime, fluate of lime, carb of lime, &c. &c. Moſt of theſe ſalts are in a grea ſmaller abundance found in nature. They may be pared by art.

3. Nature affords SULPHATE OF LIME.

I. SULPHATE OF LIME is known alſo by the na *ſelenite*, *plaſter*, or *gypſum*. It is often found in ſtrat great extent. Whole mountains are indeed compo this matter, with a ſtratification of aluminous or a ceous marle, covering it. Naturaliſts have diſting many varieties of it. It is found in tranſparent rhomb plates, like ice. It appears in arrow-heads, conſiſti two ſcalene triangles joined together. It exiſts in de dral rhomboids, in hexahædral priſms, in lenticular c of the figure of a cock's comb, in a ſilky gypſum of and other places, in the common greyiſh white ſtone ſpangled with ſmall ſparkling cryſtals, in a gy alabaſter of ſmall layers half-tranſparent, in a gypſu markable as being coloured, veined, ſpotted, cloude punctured. It is ſometimes found in ſolution in th ter of wells. It ſeems to be formed in nature by th dual decompoſition of pyrites, which affords ſulphuri capable of remaining in ſolution in water, till it conveyed into contact with LIME.

4. Its properties.

This SULPHATE OF LIME, by expoſure to the act fire, loſes the water of its cryſtals. Suddenly expoſe ſtrong heat, it decrepitates, aſſumes a rough white a ance, and becomes friable. Mixed with water, it is w eaſily into a paſte of which very white and beautiful in moulds. The long action of intenſe heat redu-PHATE OF LIME to a ſort of glaſs. A ſtream of vi-poured upon it with flame, by the blow-pipe, like-lts it. This and all other calcareous ſalts acquire horeſcent power, when laid upon hot iron. From ion of the open air, it ſuffers no very obſervable al- ; yet, in the atmoſphere, the ſparkling poliſhed of this ſalt loſe their luſtre, aſſume the variegated of the rainbow, ſplit into laminæ, and at length way. According to the chemiſts of Dijon, 500 f water are requiſite to diſſolve one part of CALCA-SULPHATE. The evaporation of this ſolution, af-he ſalt in cryſtals reſembling thoſe of nature. *Baryt* with the ſulfuric acid, a greater affinity than lime y conſequence decompoſes CALCAREOUS SULPHATE; ſolution of baryt, if poured into water containing a of this ſalt, inſtantly forms ſtriæ of barytic ſulfate. having a greater affinity with oxygen, than ſul-robs the ſulphuric acid of this part of its compoſi-effects a conſequent diſengagement of carbonic acid; ves for the ſolid reſidue of a mixture of this carbon lphate of lime, a compound matter; which conſiſts and ſulphur, and is accordingly to be denominated URE OF LIME.

Its uſes.

to the uſes of SULPHATE OF LIME; theſe are nume-nd important. Its natural varieties form ſome of ſt ornamental ſpecimens in the mineralogiſt's cabinet. s pieces of handſome furniture are formed out of er. *Plaſter-ſtone* is burnt into lime with great utility. s an excellent manure, upon being reduced to a r. It may be applied alſo to other purpoſes.

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6.
RATE
LIME.

II. Nitrate of lime; the neutral ſalt reſulting from the combination of lime with the *nitric acid;* is alſo to be found in nature. It is formed on the ſides of walls, in places which are inhabited by animals; in putrefying animal matters; in ſome mineral waters. It exiſts in large quantities in mother-water of ſaltpe're. Regularly cryſtallized, it exiſts in ſolid priſms, having ſix faces, and terminating in dihædral pyramids. It is more ordinarily obtained in ſmall needles, adhering together, and of an indeterminate form. Its taſte is bitter and diſagreeable. It eaſily liquefies in the fire, and becomes ſolid by cooling. After being heated, it ſhines with a phoſphoric light in the dark. On burning coals, it liquefies and detonizes ſlowly as it becomes dry. Long expoſed to the action of heat, it loſes its acid; which the heat decompoſes. The products of this operation being collected, are found to be vital air, gas azote, and towards the end of the operation—nitrous gas, with a ſolid reſidue of pure lime. It eaſily attracts, and deliquiates by, the moiſture of the atmoſphere. 2 parts of water are ſufficient to diſſolve 1 part of nitrate of lime. This ſolution, evaporated to the conſiſtency of ſyrup, and then ſet aſide to cool, affords the ſalt in long priſmatic cryſtals, bundled together in needles diverging from a common centre. Leſs ſtrongly evaporated, but expoſed after the evaporation to a dry warm temperature, the ſolution would afford more regular cryſtals, like thoſe of nature. *Silica* and *alumin* attract away the acid from nitrate of lime. *Baryt* alſo decompoſes this ſalt. The *ſulphuric* diſengages the nitric acid from this ſalt with effervеſcence; affording a precipitate of ſulphate of lime, and leaving the nitric acid free in the ſupernatant liquor. Sulphate of lime, however, effects no alteration on nitrate of lime. Even diſſolved

the ſame water, theſe two ſalts cryſtallize ſeparately.
AREOUS NITRATE is applied to no uſe, unleſs perhaps
dicine, as a diſcuſſive.

7.
MURIATE OF LIME.

. MURIATE OF LIME abounds in nature, wherever
ite of ſoda is formed. To ſea-water, it is this ſalt
h communicates its acrid taſte. But, it is formed
in nature. To obtain it pure, we muſt directly ſatu-
muriatic acid with LIME. When dry and ſolid, it ap-
in priſms with four ſtriated faces, terminating in ve-
arp-pointed pyramids. Their taſte is ſaline, and very
greeably bitter. The water of their cryſtallization
es them to liquefy, when they are expoſed to a mode-
heat; but the ſalt becomes again fixed by cooling.
acid is not expelled even by a more intenſe heat. But
red-hot ſhovel the cryſtals of this ſalt become luminous
e dark. If expoſed to the air, MURIATE OF LIME rapid-
tracts moiſture, and deliquiates. It muſt be kept in a
ully ſtopped veſſel, when we wiſh to preſerve it in its
alline form. One pint and a half of water, are ſufficient
ſolve one part of muriate of lime. If the water be hot,
l diſſolve a portion more than equal to itſelf in weight.
ſolution evaporated to the conſiſtency of a ſyrup, and
left to cool ſlowly, cryſtallizes in tetrahædral priſms,
ſeveral inches long, diſpoſed in the order of radii di-
ng from one common centre. Too much evaporated,
o haſtily cooled, it becomes a ſhapeleſs maſs, with
points on the ſurface. Evaporated to 45° of Baumé's
neter, and then expoſed to cold in a bottle, a ſolution
URIATE OF LIME depoſites very regular, and often ve-
rge priſmatic cryſtals. This ſolution, if ſhaken before
cryſtallized, is ſuddenly formed into a very ſolid maſs,
gives out much heat at the inſtant of its aſſuming this

new

BOOK VI. SECT. IV. new form. Baryt decompoſes CALCAREOUS MURIATE, b detaching the acid. CALCAREOUS MURIATE, and *calcare nitrate*, if diſſolved together in water, can ſcarcely be ſep rated, becauſe they are both cryſtallized by the ſame law MURIATE OF LIME has not yet been applied to many uſ in the arts of life. It exiſts in a large proportion, in a fo of common ſalt that has been recommended in France, a purging diſcuſſive in ſcrophulous caſes. It is probab that its effects might be beneficial in all diſtempers, in o der to the cure of which, an alteration of the humours requiſite.

8. Borate of lime. IV. BORATE OF LIME, the combination of the *boracic-acid* with LIME, has never yet been examined. But LIME decompoſes borate of ſoda; and we know of courſe, that it muſt be ſuſceptible of combination with the *boracic acid*. The concrete *boracic acid* has been obſerved by the chemiſts of Dijon, to afford, when treated in fire with ſlaked LIME, a matter of which the parts have but a very ſlight mutual coheſion, and take no hold on the crucible. Mr Baumé obtained, by ſaturating boracic acid with *lime-water*, and then evaporating the ſolution, yellowiſh pellicles having a faint taſte of the acid. A filtered ſolution of boracic acid with ſlaked lime, afforded to the academicians of Dijon, a copious white precipitate, by the re-agency of a fixed alkali.

9. Fluate of lime. V. FLUATE OF LIME; the combination of the *fluoric acid* with LIME; is abundantly diſperſed throughout the mineral kingdom of nature. It appears uſually in the form of very regular cubic cryſtals, of various colours, and of an icy o vitreous tranſparency. Its fracture is ſparry, and exhibit cubical plates appearing as if cracked at the ſurface. It i broken, when ſtruck againſt ſteel; and is always found a

mon

ral ores, ſerving to them as a bed or matrix. imes ſparry, and in irregular maſſes. It is ſome-ed, clouded, veined, and often green, red, roſe, oloured, &c. Ten different remarkable varieties e been particularly diſtinguiſhed by naturaliſts. ight are cubic, and diſtinguiſhed as being opaque rent, and as coloured white, yellow, reddiſh, violet: One is in octohædral cryſtals: One in an lamellated maſs: One in layers of various thick-various colours. England is very rich in CALCA-ATES. Analyſed, theſe natural CALCAREOUS FLU-uſually found to afford various other extraneous ich as ſilice, alumin, iron, with which they have minated.

l to moderate heat, this ſalt becomes phoſphoreſ-, if the heat be urged to intenſity, the phoſpho-eaſes. This intenſe heat deſtroys its green or ur, and makes it grey and friable. Sudden ex-ſtrong heat, cauſes it to decrepitate. Thrown in upon a red-hot iron, it gives a momentary blue-olet light. Expoſed a ſecond time to the ſame no longer exhibits the ſame phænomenon. A t melts it into a tranſparent uniform. In its fu-ll melt along with it, quartz equal to one-fourth weight. It is inalterable by air, inſoluble in wa-concentrated ſulphuric acid expels the fluoric FLUATE OF LIME. To accompliſh this,—Put f powdered FLUATE OF LIME, with three parts c *acid*, together into a glaſs retort. Without the of external heat, the mixture becomes gradually fferveſcence is produced; and fluor-acid-gas is : A part of the corroded ſilice of the retort is ſublimed

)OK VI. ECT. IV. ſublimed in the acid gas ; but is ſoon precipitated by me of water in the receiver. The *nitric* acid alſo decomp FLUATE OF LIME, but with phænomena which have not been obſerved with ſufficient accuracy. The *muriatic* is alſo ſaid to ſeparate the *fluoric* acid from this neutral FLUATE OF LIME may be employed as a flux in mel mineral ores ; or in aſſays.

10. RBONATE LIME.

VI. CARBONATE OF LIME is a ſubſtance exceedingly bundant in nature. It is found in many different form aggregation. All the ſhells of marine animals, are of ſubſtance chiefly : Mountains of chalk, and the ſofter ta of marle, have the ſame compoſition : All thoſe ma of which the naturaliſt numbers ſo many different varie and which are accommodated to many uſeful and o mental purpoſes in the arts of life, are equally of calc ous carbonate : This ſubſtance is diſſolved in waters, is depoſited from them in incruſtations, in ſtalactites, ſtrata of alabaſter : All thoſe numerous varieties of ſp cryſtallizations, which are known under the general ap lation of calcareous ſpars, conſiſt of one or another of calcareous neutral ſalts ; and by far the greater numb them are CALCAREOUS CARBONATES.

The fact, that, in theſe bodies, lime is combined wi aerial and an acid ſubſtance, has become known to miſts, principally in conſequence of the experiments diſcoveries of the illuſtrious BLACK. He firſt taught, evinced by experiments the moſt ſatisfactory, that al earths and alkalis were ſubject to neutralization by a ous ſubſtance. The ſuſceptibility poſſeſſed by that ſtance, of exiſting now in a concrete, now in a gazeous naturally ſuggeſted, that, in its gazeous ſtate, it muſt o expanſion to the preſence of a quantity of heat whi not then make itſelf perceptible to the ſenſes: and the doctrine of LATENT HEAT was of courſe ſuggeſted; to be afterwards modified into the LAVOISIERIAN doctrine of CALORIC. A wide field of philoſophical ſcience was thus laid open. The nature of the gas extricable out of chalk and other earthy and alkaline ſubſtances, appeared from all its more conſiderable properties, to be different from common atmoſpheric air. This doctrine with which have concurred the notions and experiments of PRIESTLEY and of the great Swediſh chemiſts; enlarged the minds of chemiſts in general to conceive the poſſibility of the exiſtence of a variety of different gaſes, and with it of the compound nature of thoſe gaſes. It is from the train of experiments and conjectures which were thus firſt encouraged and directed by the diſcoveries of BLACK, that philoſophers have been gradually conducted to the knowledge; that HEAT never aſſumes thoſe modifications nor acts that part, which were formerly aſſigned to it under the name of *phlogiſton*; that, the atmoſphere is not a ſimple ſubſtance, but a mixture of aeri form compounds; that, the greater number of the different undecompounded ſubſtances in nature, are ſuſceptible of the gazeous form; that water, acids, gaſes, and many other ſubſtances once thought ſimple, are compounds: that *heat* or *caloric*, while diffuſed in ſuch abundance throughout nature in a free ſtate, exiſts perhaps in no leſs abundance in a combined ſtate, in almoſt all matters, gazeous, liquid, or even ſolid.—This compound, then, of LIME with *carbonic acid*, exiſting in nature in ſuch abundance, and under a diverſity of phyſical appearances, is to be beaten into a powder in order that we may examine its chemical qualities. It is, in this form, white and opake. Kept for ſome time in the mouth, it contracts the fibres of the

the tongue and palate; but has not otherwiſe any very ſe ſible taſte. The action of fire expels the acids, and diſſ pates the water of cryſtallization. Diſtillation by a ſtron heat, gives, in the receiver, the carbonic-acid-gas and th water; leaving the lime, as a reſidue in the retort. Whe ſtone retorts are uſed in this diſtillation, a part of the aci gas eſcapes through their ſides. An iron-retort is therefo to be prepared: But in this caſe, the action of the wate on the iron, always affords, with the products of the CAR BONATE OF LIME, likewiſe a ſmall portion of gas-hydrogen If expoſed to an intenſe heat in crucibles of clay, the cla acting as a ſort of flux to the CARBONATE OF LIME, make it to melt into a glaſs, around the ſides of the crucible Pure air does not at all alter CARBONATE OF LIME. Th rays of the ſun, acting upon it in a humid atmoſphere, a found to deſtroy its tranſparency, and the coheſion of i laminæ. *Waters* running over beds of cretaceous matte ſuch as thoſe of Arcueil near Paris, and of San Philippo i Italy, contain CALCAREOUS CARBONATE in ſolution. It i by depoſition from ſuch waters, that cretaceous incruſtations, ſtalactites, and ſtrata of alabaſter, are formed. Mixed with ſilice, in the proportion of $\frac{2}{3}$ or $\frac{1}{4}$, CARBONATE OF LIME, operates as a flux to that pure earth. Neither baryt nor magneſia is capable of acting on CARBONATE OF LIME in the humid way. A vitreous combination may be effected between CALCAREOUS CARBONATE and theſe ſubſtances, by the intervention of a ſtrong heat. The ſulphuric, the nitric, the muriatic, and the fluoric acids decompoſe this ſalt by expelling the carbonic-acid-gas, and combining with the baſe. An effervеſcence, and a ſenſible cold attend this decompoſition. The boracic acid alſo, mixed with powdered chalk, and diluted with a ſufficient quan-

ty

of water decompoſes CARBONATE OF LIME with ſimilar henomena. It is by its combination with the carbonic cid, than LIME is in this compound, ſo much more ſoluble in water, than when in its pure ſtate.

Spars and calcareous matters in general, adorn the cabinets of the natural hiſtory; are reduced to lime for all the ſes of that ſalino-terrene ſubſtance; in marbles and alabaſters, ſerve for the purpoſes of the ſtatuary and the architect; in ſhells, and marles form one of the moſt valuable manures which are known to agriculture. A multitude of other uſeful purpoſes in the arts of life are ſatisfactorily ſerved by the uſe of the natural varieties of this ſalt.

II.
Other CALCAREOUS NEUTRAL SALTS.

VII. SUCCINATE OF LIME; the combination of lime, with the ſuccinic acid; is a ſalt in cryſtals, and of difficult ſolution; but which has not yet been particularly examined through all its relations.

VIII. ACETITE OF LIME, is the neutral ſalt formed by the combination of lime with the *acetous acid*. It is formed by the decompoſition of powdered CARBONATE OF LIME with the acetous acid. Its cryſtals are beautifully needled, and gloſſy like ſatin. It is ſour and bitter, and liable to effloreſce in the air. It is decompoſable by fire, by the mineral acids, and by the fixed alkalis.

IX. TARTARITE OF LIME, is an almoſt inſoluble ſalt formed by the combination of LIME with the tartareous acid.

X. OXALATE OF LIME, is a ſalt, inſoluble in water, pulverulent, not decompoſable by fire. It may be formed by the decompoſition of any other calcareous neutral ſalt; for no other acid has ſo ſtrong an attraction as the *oxalic acid* for lime. It gives a green hue to ſyrup of violets.

XI. GALLATE OF LIME is a ſalt ſoluble in water, whic is formed by the combination of the gallic acid with thi ſalino-terrene ſubſtance. The gallic acid decompoſes calcareous carbonates.

XII. CITRATE OF LIME is a neutral ſalt in which the acid adheres with great tenacity, but which has not yet bee very particularly examined.

XIII. MALATE OF LIME is a peculiar neutral ſalt, in ſmall irregular cryſtals which are ſoluble in boiling water, in vinegar, and in the malic acid itſelf.

XIV. BENZOATE OF LIME is a ſalt of which the properties remain to be examined.

XV. PYRO-LIGNITE OF LIME, the compound of LIME with the pyro-ligneous acid, has not yet been examined.

XVI. As little have chemiſts traced the relations of PYRO-MUCITE, the neutral ſalt formed by LIME in combination with the PYRO-MUCOUS ACID.

XVII. LACTATE OF LIME is a deliqueſcent ſalt formed by the union of *lime* with the *lactic acid*.

XVIII. SACCHO-LACTATE OF LIME is an almoſt inſoluble ſalt.

XIX. FORMIATE OF LIME is known to be cryſtallizable and ſoluble.

XX. PRUSSIATE OF LIME is a combination, which diſſolved in water, exhibits a fine bright yellow colour, and which is eſteemed by SCHEELE and FOURCROY, one of the beſt teſts that can be employed to aſcertain the preſence or abſence of iron.

XXI. SEBATE OF LIME is a cryſtallizable ſalt, not decompoſable by heat.

II. LITHIATE OF LIME is formed by the combination
'c *acid* with *lime*, but has not yet been particularly
ned.

III. PHOSPHATE OF LIME is a ſalt formed by the com-
on of phoſphoric acid with lime, and is ſcarcely ſolu-
nleſs the acid be preſent in exceſs.

ſe are all the neutral ſalts which LIME is certainly
n to form with any of the acids, whether aerial,
al, vegetable, or animal in their origin. Many of
require to be much more particularly examined. They
probably be advantageouſly applicable to a variety
ful purpoſes that have not yet been thought of.
is a wide field for chemical reſearch.

SECTION FIFTH.

OF MAGNESIA, AND ITS COMPOUNDS.

BOOK VI. SECT. V.

1. Dr BLACK's diſcovery reſpecting MAGNESIA.

MAGNESIA is an earth, or rather a ſalino-terre
ſtance, which nature never preſents to us in a pur
Dr BLACK firſt fixed the line of diſtinction betwee
NESIA and *lime* ; And he alſo was the firſt who e
that MAGNESIA as well as lime and the alkalis, was a
neutralized by carbonic acid, in thoſe caſes whic
had all been ſuppoſed to be indeed mild, but ce
pure.

2. Qualities of MAGNESIA.

It appears in a white powder, which, both to t
and the finger, reſembles meal. Its ſpecific gravity is
2,33. It has no taſte to the tongue, but is purga
the ſtomach. It communicates a pale green colour
tincture of violets and mallows,—to turnſole, a bl
our. We know not, in what manner it is ſubjec
affected by light. The moſt intenſe ignition does n
nor decompoſe magneſia, but is capable of making
tract in all its dimenſions, ſo as to corrode an iron
This contractile property ſeems to reſemble that by
alumin is fitted to become a pyrometer. If heated
retort, it ſtill retains tenaciouſly that water with whi
commonly mixed, but acquires a very diſcernible
phoreſcence. Very long expoſure to the atmoſphere,
to enable magneſia to attract at laſt from it, ſome
portion of carbonic acid. At the ordinary tempera
the atmoſphere, 7900 parts of water, are required
ſolve 1 part of magneſia. It forms, however, with w

action of fire, or even of the dry atmoſphere. Heat-
th ſilice and alumin together, MAGNESIA runs with
into a glaſs. It is uſeful in medicine, as an abſorbent
urgative. It will preſerve fleſh for a long time from
faction, and will even reſtore putrefied bile. It is
make camphor, opium, reſins, and gum-reſins ſolu-
water; and to form ſome valuable dyes. It forms
the acids, the following neutral ſalts.

3.
Neutral ſalts into which it enters.

SULPHATE OF MAGNESIA is the compound formed by
nion of the ſulphuric acid with this ſalino-terrene ſub-
. It is obtained from Epſom wells in England, from
lt-ſprings of Lorraine, and the ſalt-works of Nar-
in France, from the waters of Egra, Sedlitz, and
chutz. It is ſometimes found efflореſcent upon ſchiſti.
reedily devoured by birds of paſſage.

s ſalt has a very bitter taſte. In commerce, it ap-
in ſmall needles terminating in very ſharp-pointed
ids. When regularly cryſtallized, its taſte is more
, it does not effloreſce in the air, and the cryſtals are
different form. Its cryſtals are in this laſt caſe ſine
ngular priſms, terminating in quadrangular pyra-
Its water of cryſtallization is ſufficient to make it
ible of aqueous fuſion. It melts by the moſt moder-
at into what, when cooled, appears a ſhapeleſs maſs.
intenſe heat brings it to actual igneous fuſion. Ex-
to the atmoſphere, it loſes its tranſparency, and even
s a ſort of ſlight effloreſcence. At the temperature
Fahrenheit, water diſſolves, according to *Chaptal*, a
y of MAGNESIAN SULPHATE, equal to itſelf in weight.
ter diſſolves a quantity equal to twice its own weight.
allizes regularly by ſlow, ſpontaneous evaporation.
lecompoſed both by magneſia and by lime, which

have

BOOK VI. Sect. V.

have ſtronger attractions for the ſulphuric acid. Po into a ſolution of MAGNESIAN SULPHATE, a ſmall quantity lime-water, or *vicè verſâ*; there enſues a precipitation of p magneſia and of calcareous ſulphate. A ſolution of ſu phate of lime mingled with a ſolution of ſulphate of ma neſia, is ſaid to afford a precipitate of magneſia. Calcare ous nitrates and muriates likewiſe decompoſe ſulphate o magneſia, and are in their turn decompoſed by it. Doubl elective attractions appear to act here. *Bergman* relat that an Cwt. of magneſian ſulphate contains, if in cryſtal 19 parts of pure magneſia, 33 of ſulphuric acid, 48 of wa ter.. It is uſed as a purgative medicine; and moſt wate which are naturally purgative, owe this quality to the pr ſence of MAGNESIAN SULPHATE.

II. NITRATE OF MAGNESIA is a neutral ſalt formed b the combination of nitric acid with this ſalino-terrene ma ter. It is uſually found in what is called *mother-water* o nitre. *Bergman*, by a proper evaporation of a ſolution o this ſalt, obtained the ſalt in priſmatic, quadrangular, an ſpathoſe cryſtals, without pyramids. *Chaptal* relates, that h himſelf accidentally found in mother-water of nitre, concen trated to 45° of his areometer, a non-deliqueſcent cryſtal o MAGNESIAN NITRATE, priſmatic, with four ſides very muc flattened, very thick, and very ſhort. BERGMAN aſcribes t MAGNESIAN NITRATE in cryſtals, a conſtant tendency to de liqueſce by attracting moiſture from the atmoſphere. *Qua tremere-Dijonval*, on the contrary, deſcribes this ſalt, as bein diſpoſed to effloreſce,—but in its pure cryſtalline ſtate, not able to deliquiate. The taſte of this ſalt is acrid and bitte It readily diſſolves in water. It is decompoſable by baryt lime, and the alkalis. The ſulphuric, the fluoric, an even with the help of heat the boracic acid, diſe acid from MAGNESIAN NITRATE, and form new neutral ſalts by combination with the MAGNESIA. The ſulphates of all the alkalis are ſubject to be decompoſed by MAGNESIAN NITRATE. It is ſaid, but with little probability, that if MAGNESIAN NITRATE and CALCAREOUS NITRATE be diſſolved together in the ſame water, the latter ſalt will produce a precipitation of the former. It is probable, that magneſian nitrate, if adopted in medicine, might act powerfully on the animal œconomy.

III. MURIATE OF MAGNESIA, the ſaturated combination of MURIATIC ACID with MAGNESIA, exiſts in all natural ſalt waters, and in all waters which contain *magneſian ſulphate* in ſolution. It is obtained in cryſtals by concentration, evaporation, and extreme and ſudden cold. Its cryſtals are in the form of minute needles: Its ſolution is a tranſparent jelly. Chemiſts have not agreed, whether the cryſtals tend to deliquiate or to effloreſce in the air. The action of fire, decompoſes the neutral ſalt, and expels the acid. It is readily ſoluble in water. To obtain it in cryſtals, is a matter of great difficulty. Heated in a retort with ſilice and alumin, it gives out its acid. Baryt and lime precipitate the MAGNESIA from this ſalt. From the mother-waters of muriate of ſoda in ſalt ſprings, the magneſia which thoſe waters contain in union with muriatic acid, may be precipitated at a ſmall expence by means of lime-water. The ſulphuric and the nitric acids decompoſe MAGNESIAN MURIATE by expelling the muriatic acid with effervеſcence. The relations between MAGNESIAN MURIATE and the alkaline neutral ſalts, ſhall be hereafter explained.

IV. BORATE OF MAGNESIA is a ſalt, ſcarcely known. A portion of MAGNESIA put into a ſolution of *boracic acid* is ſlowly diſſolved. The liquor affords by ſubſequent evaporation,

poration, granulated cryſtals of an irregular form. Fire melts, but does not decompoſe this ſalt. The other acids attract the MAGNESIA, and thus ſeparate the *boracic acid*. On the whole, the attractions between MAGNESIA and *boracic acid* are certainly not very ſtrong.

V. FLUATE OF MAGNESIA is a ſalt which BERGMAN only, has examined. The *fluoric acid* diſſolves MAGNESIA with great energy. When the quantity of acid is nearly ſaturated, there is a great part of the newly formed ſalt precipitated. The ſolution affords by ſpontaneous evaporation, a ſort of tranſparent froth which hangs on the ſides of the veſſel, and conſiſts in part of long cryſtalline threads. With theſe, are obtained, at the bottom of the veſſel, ſpathoſe cryſtals in hexagonal priſms, terminating each in a ſhort pyramid which conſiſts of three rhombs. Even the extreme violence of fire alters not this ſalt. No acid has ſtrength to decompoſe it in the humid way. It is worthy of a more particular examination.

VI. CARBONATE OF MAGNESIA is a ſaturated combination of MAGNESIA with carbonic acid. It is prepared by precipitating a ſolution of magneſian ſulphate with carbonate of potaſh.

It has generally an earthy appearance, and is in the form of a white powder. It may contain the acid in a greater or a ſmaller proportion : And its properties vary with the proportions of the acid. Its taſte is crude and terrene. It affects the inteſtines with a purgative power. Expoſed to heat in a crucible, it loſes both its water and acid. The diſengagement of the acid gas, makes it, upon this occaſion, bubble, and exhibit on the ſurface, the motions of a fluid. A thin vapour ariſing out of the crucible, depoſites on contiguous bodies, a portion of the magneſia carried off

e carbonic acid. A body, even if warm, but ſtill more
id, attracts the ſalt, if caſt into the crucible during the
ſs A blueiſh phoſphoric light is produced toward
nd of the operation. The uſe of a pneumato-chemi-
pparatus, during this proceſs, enables us to obtain the
r and the acid which are evaporated. An hundred
ds of ſalt may contain about 25 or 30 of the acid, 30
ater, 40 or 45 of pure MAGNESIA. From expoſure to
ir, MAGNESIAN CARBONATE undergoes no very remark-
alteration: Yet a very humid atmoſphere makes it
me the form of ſmall clods, and exhibit the appearance
commencing deliqueſcence. *Water* diſſolves but little
his ſalt. A quantity of magneſian carbonate mingled
a ſmall portion of water, compoſes a ſort of paſte of
e tenacity. Diluted in a very large proportion of wa-
MAGNESIAN CARBONATE diſſolves ſlowly in the propor-
of a quarter of a grain of the ſalt to an ounce of the
d. Pure *earth* does not decompoſe MAGNESIAN CAR-
ATE. Lime abſtracts the acid. The alkalis decom-
e this ſalt. The ſulphuric, the nitric, and the muriatic
s decompoſe MAGNESIAN CARBONATE by combining with
MAGNESIA. It ſeems however to be rather the fire than
new acid which on theſe occaſions expels the carbonic
gas. Water containing carbonic acid, diſſolves MAG-
IA with much more energy, than can be exerted upon it
ure water. There takes place on this occaſion, a ſuper-
ration of the CARBONATE OF MAGNESIA with carbonic
. The ſolution gives a green tinct to ſyrup of violets.
expels the exceſs of acid; but even congelation does
ſeparate the magneſia from the water. The heat of
52′ Fahrenheit, gives to this ſolution a milky con-
cy. Sudden cold makes it again tranſparent Slow
evaporation

evaporation gives the MAGNESIAN CARBONATE in hemiſpherical maſſes of needled cryſtals with divergent threads. Th needles, examined by the microſcope, appear to be long ſixſided priſms truncated with a hexagon, and reſemblin certain ſpars. Cryſtals of MAGNESIAN CARBONATE may likewiſe be obtained by expoſing to the air, for a few days, a ſolution of this ſalt precipitated by heat. A ſolution of MAGNESIAN CARBONATE prepared for the laboratory, will often depoſite at the end of a few days, even in well ſtopped phials, no ſmall quantity of very fine, bright, ſmall needles which the magnifier ſhews to be ſix-ſided priſms. There is no reaction between MAGNESIAN CARBONATE and thoſe other neutral ſalts which are formed with the alkalis. The calcareous neutral ſalts are decompoſable by CARBONATE OF MAGNESIA; for the attractions between lime and carbonic acid are very ſtrong. MAGNESIAN CARBONATE is beſt obtained for uſe, by pouring a hot ſolution of magneſian ſulphate into a ſolution of carbonate of potaſh. A precipitate of MAGNESIAN CARBONATE is thus obtained. As a purgative, MAGNESIAN CARBONATE is preferable, in medicine, to pure MAGNESIA. As an abſorbent, pure MAGNESIA is to be preferred.

VII. PHOSPHATE OF MAGNESIA is a neutral ſalt which we eaſily form by exhibiting *phoſphoric acid* to *magneſian carbonate*. The carbonic acid is expelled; and the *phoſphoric acid* forms with the MAGNESIA, a ſcarcely ſoluble neutral ſalt. Its concentrated ſolution affords in the ſpace of 24 hours, ſmall flat needle cryſtals, very ſlender, ſeveral lines in length, and cut obliquely at the ends. This ſalt alſo takes often the form of a tranſparent jelly. Theſe cryſtals of PHOSPHATE OF MAGNESIA, if expoſed to a gentle heat, fall into powder. The ſulphuric acid decompoſes this ſalt.

VIII. SUCCINATE OF MAGNESIA formed by the combination of MAGNESIA with the *ſuccinic acid*; decompoſes the alkaline *ſuccinates*, and is itſelf decompoſable by the *ſuccinates* of lime and baryt.

IX. ACETITE OF MAGNESIA formed by the combination of magneſia with acetous acid, is extremely ſoluble in water, decompoſable by fire, baryt, lime, the mineral acids, and the alkalis; ſubject to afford, not cryſtals, but by evaporation, a viſcid, deliqueſcent maſs.

X. TARTARITE OF MAGNESIA is a ſalt of which we know only, that it appears not in a cryſtalline form, but as a gelatinous matter.

XI. PYRO-TARTARITE OF MAGNESIA is indeed a peculiar neutral ſalt. But, its qualities have not yet been examined.

XII. OXALITE OF MAGNESIA is the combination of *magneſia* with what is called the oxalic acidulum. It is a white ſalt in powder, decompoſable by fluoric acid and by baryt.

XIII. GALLATE OF MAGNESIA, the combination of this alkalino-terrene ſubſtance with the *Gallic acid*, is a ſalt ſoluble in water, eſpecially when there is an exceſs of the baſe.

XIV. CITRATE OF MAGNESIA is a ſalt which we know MAGNESIA to form with the *citric acid*, but which has not yet been examined.

XV. MALATE OF MAGNESIA is a deliqueſcent ſalt, the combination of magneſia with the *malic acid.*

XVI. BENZOATE OF MAGNESIA is a neutral ſalt of unknown properties.

XVII. PYRO-LIGNITE OF MAGNESIA has not yet been examined.

XVIII. PYRO-MUCITE OF MAGNESIA is as little known the foregoing ſalt.

BOOK VI. SECT. VI.

XIX. CAMPHORATE OF MAGNESIA is a pulverulent, ſoluble ſalt.

XX. LACTATE OF MAGNESIA exhibits itſelf in deliqueſcent cryſtals.

XXI. SACCHO-LACTATE OF MAGNESIA is almoſt inſoluble.

XXII. FORMIATE OF MAGNESIA is decompoſable by baryt, lime, and the fixed alkalis.

SECTION SIXTH.

OF POTASH, AND ITS COMPOUNDS.

BOOK VI.
SECT. VI.

1.
Alkalis diſtinguiſhed from *Earths.*

SILICE and *alumin*, have been named by the chemiſts, EARTHS: *baryt*, *lime*, and MAGNESIA, they have called SALINO-TERRENE ſubſtances: we now enter upon the examination of POTASH, a ſubſtance, to which with *ſoda* and *ammoniac*, they have given the name of ALKALIS. We ſhall, in this book, have occaſion to examine ſome other ſubſtances of recent diſcovery, which have been ranked, with the two above mentioned, under the common character of EARTHS.

2.
Origin of the name alkalis.

The word ALKALI is of Arabic origin. It is originally the name of a plant. The aſhes of this plant afforded to the Arabians, an uſeful ſalt, to which they naturally gave the ſame name. It was afterwards perceived, that the mineral *natron* reſembled in its properties this vegetable reſiduum, ſufficiently near, to be diſtinguiſhed by the ſame generic name. Hence the diſtinctions of the mineral and the vegetable alkali. From the ſoot of fires, of which camel's dung was uſed as the fuel, was obtained a third ſaline ſubſtance. This had received the name of *ammoniac*. But, upon examination, it was found to poſſeſs certain properties in common with the two ALKALIS already known. It was therefore numbered with them, as a third *alkali*. Its volatility afforded a ſpecific difference, to diſtinguiſh it from the two former.

3.
Common qualities of the alkalis.

Theſe *alkalis* agree in having an urinous, acrid, cauſtic taſte; in turning green, the ſyrup of violets; in exciting heat, when they unite with water; in abſorbing moiſture and carbonic acid gas from the atmoſphere; in diſſolving earths by the force of their tendency to combination; in rendering

rendering oils miſcible with water. The diſtinctio the *alkalis* from the *acids*, appears to have been one of ſteps in the progreſs towards ſcientific claſſificatio chemiſtry.

4. haracter f potaſh. POTASH, otherwiſe called the vegetable alkali, wa known in a ſtate of perfect purity, until diſcovered b *BLACK*. It is white, dry, and ſolid. It diſſolves contexture of the ſkin. It gives to ſyrup of violets, a green colour, much more diſcernible than that which cauſes the ſame ſyrup to aſſume. It at laſt turns the ginal colour to a brown yellow.

5. ts principal hemical elations. We know not in what manner *light* affects this ſalt. *fire* in cloſe veſſels, it is ſoftened, and ſoon lique Poured upon a ſmooth hard ſurface, it cools into a w opake maſs. Only the moſt intenſe heat is ſufficien volatilize it. In the open atmoſphere, it attracts moiſt diſſolves into a liquid, and abſorbing carbonic acid f the atmoſphere, gradually paſſes into the ſtate of a ne ſalt. Its weight is now increaſed.—In water, it diſſ very readily; excites at the ſame time a conſiderable h and a fœtid lixivious odour. The ſolution is colour Evaporation to dryneſs in cloſe veſſels, is requiſite, to ſ rate the ſalt from the ſolvent. The action of oxygen azote upon this alkali is unknown. *Silice* combining POTASH in the dry way and by heat, is thus brought fuſion: And the compound into which theſe two ſub ces run, is the well known common GLASS. The a may be detached by acids: And the *ſilice* will then obtained pure, in a precipitate. In the act of mal glaſs, the purity, the proportion, and the complete f of the *ſilice* and the POTASH employed, are the prim things to be attended to. Some other matters are im

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ally added to theſe two, for the purpoſe of rendering glaſs more weighty and tranſparent, and to give it other uſeful qualities. The phænomena exhibited POTASH acts on *alumin*, are not yet well known. baryt, magneſia and lime, it is capable of combina- With ſulphur, it forms what is called *ſulphure of* . It has been ſuppoſed to be perhaps a combination with *azote*. It is extracted by *lixiviation* and ſubſe- t *concentration* from the aſhes of wood, ferns, and r vegetables. That impure potaſh which we meet , in commerce, is obtained from North America, or the Northern countries of Europe. In ſurgery, it is to corrode the ſkin, and to produce inflammation and ration. The following are the neutral ſalts into h it enters.

6. The neutral ſalts which it forms.

SULFATE OF POTASH, the combination of POTASH with ULFURIC ACID, is a neutral ſalt which rarely appears he mineral kingdom of nature, but is contained, in l quantity in a few vegetables. It is generally more s tranſparent. Its cryſtals vary in form and magnitude. f ſlow formation, they ſometimes aſſume the figure of ided priſms terminating in two hexahædral pyramids, h like rock-cryſtal. If obtained by rapid evaporation, ryſtals are agglutinated into one maſs in a ſolid cruſt, urface of which, is covered with ſmall, irregular, pyra- al ſpikes. Or a ſolution expoſed to gentle ſpontane- vaporation by the heat of the atmoſphere, will afford ryſtals in twelve-ſided ſolid figures joining at the baſe, ometimes ſeparated by a ſhort ſix-ſided priſm.

LPHATE OF POTASH has a very diſagreeable bitter taſte. dergoes little alteration from the action of fire. On g coals, indeed, it decrepitates. Expoſed to cold, in a ſtate of fuſion, becomes an opake maſs, friable and ſoluble. A ſtrong fire brings it into fuſion. If kept for a while in fuſion, and in an open veſſel, it is volatilized without decompoſition. From *air* it ſuffers no alteration. In cold *water*, it is ſcarcely ſoluble; in hot water, it is diſſolved in the proportion of 1 part to 4. It is cryſtallized partly by cooling, but ſtill more by evaporation. It contains but little water in cryſtals; and therefore is not liable to deliqueſce in the air. It does not act at all on the ſimple earths. It is decompoſable by baryt, which has a ſtronger affinity than potaſh, with the *ſulphuric acid.* Neither lime nor magneſia acts on SULPHATE OF POTASH. It may be ſuperſaturated with *ſulphuric acid*: And the new neutral ſalt thus formed, will exhibit ſome peculiar properties. The *nitric acid* detaches the potaſh into a new nitric combination: The *muriatic acid*, too, decompoſes ſulphate of potaſh, in order to form muriate of potaſh. But, in neither of theſe two caſes, is the whole quantity of the *ſulphate of potaſh*, diſſolved. *Carbon* and ſeveral metallic ſubſtances convert SULPHATE OF POTASH into a SULPHURE OF POTASH, by detaching the oxygen, the acidifying principle of the acid. 100 parts of SULFATE OF POTASH, contain 52 of potaſh, 40 of ſulfuric acid, 8 of water. It may be prepared—by a direct combination of the *ſulfuric acid* with POTASH; by decompoſing with the *ſulfuric acid*, other neutral ſalts in which there is potaſh contained, by uſing potaſh to decompoſe terrene and metallic ſulphuric ſalts. It has been obſerved by *Chaptal*, that SULFATE OF POTASH may be obtained from the analyſis of tobacco.—The *ſulphureous* acid forms with potaſh, a peculiar neutral ſalt in ten-ſided polyhædrons or in two tetrahædral pyramids, cut towards the baſes It is bitter, ſoluble, deliqueſcent. It is

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ble to be decompoſed by all the mineral, and by many of he vegetable acids. It is denominated SULPHITE OF POT-ASH. SULFATE OF POTASH is given, in medicine, as a ſolvent and purgative. SULPHITE is convertible into SULPHATE OF POTASH by expoſure to the atmoſphere.

II. NITRATE OF POTASH is otherwiſe named common NITRE; or SALTPETRE. It is a ſaturated combination of the *nitric acid* with *potaſh*. It is very abundant in nature. It is formed wherever there are animal and vegetable ſubſtances in a ſtate of progreſſive putrefaction; is obtained in great purity from cretaceous earths; is formed in ſteads made for the purpoſe of affording it, in ſtables and cowhouſes, in ditches and covered ſheds, on the walls of old houſes, even in the roads which are much trodden by ſheep and other cattle.

NITRATE OF POTASH exiſts in ſix-ſided priſms, terminating in dihedral pyramids, or cut at the ends ſlopewiſe, and often channelled from one end to the other. It has a freſh taſte. It alters not the colour of ſyrup of violets. It is very liable to alteration from heat. Expoſed in a crucible to the action of fire, it is ſoon liquefied by an actual ous fuſion. By cooling, it congeals from this fuſion into what is called *cryſtal-mineral*. Continued expoſure, er the fuſion, to the action of fire, reduces NITRATE OF POTASH to ſimple potaſh; diſpelling the acid. At a certain period in this continued application of heat, the NITRE will be found converted into NITRITE OF POTASH the partial diſſipation of the acid. In the preparation *cryſtal-mineral* for medical purpoſes, it is neceſſary to beware of expoſing the fuſing nitre to heat, for too long a ce of time. Expoſed in contact with other combuſtible es to the action of fire, NITRATE OF POTASH is decomploded with a detonation or decrepitation, and a white flame. This decrepitation and flame ariſe chiefly fro expanſion of the oxygen in the acid of the nitre, to bine with the combuſtible matter in contact with it. In the theory of the combuſtion of gun-powder, a mi of nitre with ſulphur and charcoal. An hundred p of gun-powder from ſome of the beſt manufactures, contain about 75 pounds of nitre or potaſh, 9½ of ſu 15 of charcoal. The mixture is effected by long co ed trituration, ſifting to granulate and cleanſe, expoſ gentle heat for drying, and friction in a barrel to glaze it, at the laſt, for uſe as gun-powder. Gun-p thus prepared, may be again diſſolved by expoſing it and unwaſhen to the action of a moderate fire. An mixture of nitre, ſulphur, and charcoal, which is *fulminating powder*, may be prepared of 3 ounces of 1 of powdered ſulphur, and 3 of carbonate of p *Powder of fuſion* is made of 3 parts of nitre, 1 of ſul 1 of ſaw-duſt. This will melt a ſmall bit of coppe nut-ſhell, without deſtroying the ſhell. *Sulphuric* ac made in England and Holland, for ſome time, by the buſtion of ſulphur and nitric acid together, in large loons of glaſs, in the proportions of 8 parts of ſulp 1 part of nitre. *Sulphuric acid* may, however, be m a leſs expence, by burning ſulphur on gridirons in chambers lined with lead. The *clyſſus of nitre* is pre by the detonation of different combuſtibles with nitr potaſh, in cloſe veſſels. The reſidue which remains the detonation of nitre with charcoal in a crucible, i to be *nitre fixed by charcoal*; but is properly nothin than potaſh in combination with carbonic acid. NIT OF POTASH is extracted pure and in its perfect cryſ

from thoſe matters among which it is formed, by ſo-
in boiling water in the proportion of 3 or 4 parts of
ater to 1 of the nitre,—and by ſubſequent cooling.
firſt pellicles which are formed on the cooling liquor,
be ſkimmed off and diſpoſed of apart, as being only
te of ſoda. The uſe of aſhes, and repeated boilings,
ally enable the manufacturer to ſeparate all the ex-
ous ſalts; and after the third ebullition, to obtain the
NITRATE OF POTASH in large irregular maſſes, and in
cryſtalline ſticks. That which is in irregular maſſes,
ng little or no water of cryſtallization, is the fitteſt for
manufacture of gun-powder. It may be ſtill farther
ſed by new ſolution and cryſtallization.

ITRATE OF POTASH is not inalterable by *ſilice*. Diſ-
with ſand, the neutral ſalt, is robbed of its acid. A
ous reſidue is left. Nitre diſtilled without an inter-
um, affords its acid decompoſed into gas-oxygen and
zote. *Alumin* decompoſes nitre; as has been obſerv-
the proceſs uſed at Paris for the diſtillation of aqua-
. But, it has been ſuſpected that this effect may be
g to ſome impurities in the aluminous earth. *Baryt*
mpoſes NITRATE OF POTASH, and forms with the acid,
w neutral ſalt. *Magneſia, lime,* and the *alkalis* act not
n nitre. Concentrated *ſulphuric* acid poured upon ni-
produces a diſengagement of nitrous acid gas. *Woulfe's*
ratus, above deſcribed, was ingeniouſly contrived for
purpoſe of collecting without loſs, the nitrous gas which
s from this proceſs in diſtillatory veſſels. This is a
good proceſs for obtaining nitric acid, ſince the at-
ions between *ſulphuric acid* and potaſh, are ſuperior in
gth, to thoſe which ſubſiſt between nitric acid and
h. Concrete *boracic* acid, with the help of heat, diſ-

ſolves NITRATE OF POTASH,—partly by means of its fixity,—partly by the attractions between boracic acid and potaſh. *Phoſphoric acid* alſo by its fixity, decompoſes this alkaline ſalt, in the dry way only.

NITRATE OF POTASH is employed in the arts, in the manufactures of gun-powder, and in thoſe *fluxes* of nitre and tartar which are uſed in aſſaying metals, &c. In medicine, it is given in doſes of—from 10 or 12 grains to 1½ drachm or more, as a quieting, cooling, refreſhing, diuretic, antiſeptic remedy, &c. 100 grains of the cryſtals of nitre contain 30 acid, 63 alkali, and 7 water. Seven parts of water diſſolve 1 part of nitre at the temperature of 60° Fahrenheit.

III. MURIATE OF POTASH is a ſaturated combination of potaſh with the muriatic acid. It is frequently met with in nature; but, never in large quantities together. It is formed in ſea-water, in the water of ſalt ſprings, ſometimes in the ſame places where nitrate of potaſh is found, in vegetable aſhes, and in ſome animal humours. Art produces it by the direct combination of the muriatic acid with potaſh, by decompoſing with the ſame alkali, earthy, ammoniacal, or metallic ſulphures, or by decompoſing with muriatic acid, ſulphate or nitrate of potaſh.

Its cryſtals are cubic, but always of a confuſed appearance, and an irregular form. In fire, it decrepitates by the ſudden rarefaction of the water of its cryſtals. Its taſte is ſaline, pungent, bitter, and diſagreeable. Continued expoſure to heat, melts and volatilizes, but does not decompoſe it. It is uſeful, as a *flux*, to cover melting minerals, and thus fix the action of other fluxes put to act under it. It ſcarce attracts *moiſture* from the air. About 3 parts of cold water are neceſſary, to maintain 1 part of this ſalt in ſolution. *Alumin* ſeems to decompoſe it; for [illegible]

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SECT. V

acid may be obtained by diſtilling MURIATE OF POTASH with clays. *Siliceous* earth acts on it in the ſame manner. *Baryt* ſeizes the acid. *Magneſia* and *lime* produce no alteration upon this ſalt. The *ſulphuric* and the *nitric* acids diſengage the muriatic acid with efferveſcence. In the caſe of the MURIATE OF POTASH being dry, this phænomenon is peculiarly ſtriking. The *boracic* acid likewiſe decompoſes MURIATE OF POTASH by diſtillation. Neither the *fluoric* nor the *carbonic* acid acts in any way on *muriated potaſh.* Neither *ſulphate* nor *nitrate*, whether of potaſh or ſoda, acts upon this ſalt. MURIATE OF POTASH is not at preſent applied to any uſe, either in medicine, or in the arts. 100 grains of muriate of potaſh contain 29,68 acid, 63,47 alkali, 6,85 water.

IV. BORATE OF POTASH is a ſalt which may be formed by combining POTASH with the *boracic* acid. Such is the reſidue produced, when *nitrate of potaſh* is decompoſed by the uſe of *boracic acid.* This reſidue appears in a white half-fuſed glaſs, which, when diſſolved in water, affords ſmall cryſtals. It is fuſible, ſoluble, ſuſceptible of cryſtallization, decompoſable by pure acids.

V. FLUATE OF POTASH is formed by the combination of POTASH with *fluoric* acid. It appears always in a gelatinous, never in a cryſtalline form. Its taſte and effect upon the ſkin, are acrid and cauſtic. *Fire* diſengages the acid; and the ſilice which was ſuſpended in it, then melts with the potaſh into a glaſs. FLUATE OF POTASH readily diſſolves in water. Its ſaturated ſolution produces no alteration on ſyrup of violets. *Lime* decompoſes this ſalt. Concentrated *ſulphuric* acid effects a ſimilar decompoſition. This ſalt is in other reſpects little known; and is applied to no

VI.

VI. CARBONATE OF POTASH, is the ſaturated combination of carbonic acid with potaſh. We owe our knowledge of the exiſtence of this ſalt to DR BLACK. It is often found ready-formed in vegetables, and is obtained from them by incineration, as well as from the tartar of wine. It converts the blue colour of ſyrup of violets to a green; has an alkaline taſte; attracts moiſture from the atmoſphere; is readily obtained in cryſtals, by expoſing a ſolution of pure potaſh to the carbonic acid gas in the upper part of a barrel of fermenting beer. Its cryſtals are quadrangular priſms with ſhort four-faced pyramids. It is ſubject to alteration from *heat;* affords by diſtillation, water and carbonic acid; and, after the operation, remains in an irregular maſs. 100 parts of CARBONATE OF POTASH contain 20 of acid, 48 of pure alkali, 32 of water. When fully cryſtallized, it ſuffers no alteration from air: Its cryſtals neither deliquiate nor effloreſce. It is ſoluble in four parts of cold water,—in even a ſmaller proportion of warm water. A ſenſible degree of cold is produced while it unites with this fluid. Is is cryſtallizable by evaporation and cooling conjunctly. It ſerves as a flux to vitrifiable earths. The carbonic acid is diſengaged, while the alkali runs into a glaſs with *ſilic* *Alumin* does not act on carbonate of potaſh; but is reducible by it to a vitreous frit. *Baryt* detaches the carboni acid. *Lime* alſo detaches the acid. *Lime-water*, poure into a ſolution of CARBONATE OF POTASH, gives a precip tate of an almoſt inſoluble ſalt which is produced by th combination of lime with carbonic acid. Two pounds aſhes from the combuſtion of huſks of grapes with lees wine;—mixed with a pound of *lime;* in this mixtur immerſed in 16 pounds of water; then in the lixivi filtered, evaporated, and in the reſidue melted in a cru bl ble, and then poured out on a plain ſurface;—afford what is called the *lapis cauſticus*. This product is merely a dirty alkali, not very cauſtic. But, pure POTASH, prepared with lime to abſorb the carbonic acid, is the beſt ſubſtance to be uſed for the purpoſes of the *lapis cauſticus*. *Magneſia* does not act on CARBONATE OF POTASH. The ſulphuric, the nitric, the muriatic, and the fluoric acids decompoſe it. With heat, the *boracic* acid expels the *carbonic*. The before deſcribed neutral ſalts have no reaction with this one. It is much uſed in the arts. In medicine, it is employed, in ſmall dozes, as an aperient and diſcuſſive in obſtructions of the meſentery and the urinary paſſages.

VII. PHOSPHATE OF POTASH is a very ſoluble, neutral ſalt. It affords by careful evaporation and cooling, cryſtals in the form of tetrahædral priſms, terminating in pyramids which have alſo four faces correſponding to thoſe of the priſms. It diſſolves much better in hot than in cold water. It ſwells on burning coals, but does not eaſily melt: When melted, it has no longer a ſaline taſte. From the nitric ſolution of ſilver, it produces a white precipitate; from the nitric ſolution of mercury, a yellowiſh white precipitate. It is decompoſable by lime-water.

VIII. SUCCINATE OF POTASH, the combination of the vegetable alkali with the acid of amber, is a deliqueſcent, cryſtallizable ſalt which has been little examined, and not yet applied to uſe.

IX. ACETITE OF POTASH is a neutral ſalt of a pungent, acrid, urinous taſte. Decompoſed by the action of fire, it affords an acid phlegm, an empyreumatic oil, ammoniac, and a large quantity of ſtrong ſmelling gas, conſiſting of carbonic acid with gas-hydrogen. The reſidual coal contains a good deal of naked potaſh. This ſalt deliqueſces in the atmoſphere, and is eaſily ſoluble in water. It is decompoſable by diſtillation with ſulphuric acid,—in the proportion of 2 parts of the neutral ſalt to 2 of the acid,—in a tubulated glaſs retort fitted with a receiver. This ſalt is formed by the combination of *acetous acid* with potaſh. There is alſo ACETATE OF POTASH, reſulting from the combination of the ACETIC acid with the ſame alkali.

X. TARTAREOUS ACIDULUM, is a combination, chiefly of a large proportion of the *tartareous* acid with a ſmall quantity of potaſh which cannot be eaſily ſeparated from it. This ſalt is more like an imperfect acid, than a neutral ſalt. When very pure, it is irregularly cryſtallized. Its taſte is ſour and leſs vinous than that of crude tartar. Expoſed to heat on burning coals, it diffuſes a ſmoke of a pungent empyreumatic odour, and becomes black and carbonaceous. By diſtillation it affords a phlegm, acid, and ſlightly coloured; an oil which acquires colour and conſiſtency, and has an empyreumatic ſmell; ammoniacal carbonate; a large quantity of carbonic acid; a reſidue of coal which when lixiviated without incineration, affords a large proportion of potaſh. The TARTAREOUS ACIDULUM ſuffers no alteration from water; is ſoluble in 28 parts of boiling water, and cryſtallizes irregularly by cooling. The ſolution reddens tincture of turnſole, and has an acid taſte. Expoſure to the air decompoſes the acid, affording a precipitate of mucilaginous flakes, and in the water, a reſidue of *carbonate of potaſh*. *Magneſia* forms with this acidulum, a ſoluble ſalt, liable to decompoſition by fixed alkali; the ſolution of which affords by evaporation, ſmall priſmatic radiated cryſtals. *Lime* and *chalk* both act upon this acidulum. *Lime* forms by combination with it, a new ſalt, which is ſcarcely ſoluble, and which when diſtilled in a retort, leaves a pyrophorous reſidue. *Chalk* gives out carbonic acid, which is diſſipated—or obtained in the receiver; forms a precipitate of calcareous tartarite; and leaves a ſolution of tartarite of potaſh in the ſupernatant liquor. With the alkalis, this acidulum readily combines; forming tartarites of potaſh, of ſoda, and of ammoniac. With the acids, it forms neutral ſalts ſimilar to thoſe which the ſame acids form with potaſh. It combines with the metallic oxides. It is much uſed in medicine, and for various other purpoſes.

TARTARITE OF POTASH—is the ſaturated combination of the ſame POTASH with the *tartareous acid*, without any exceſs of the acid.

XI. PYRO-TARTARITE OF POTASH is formed by the combination of the *pyro-tartareous acid* with this alkali. It is known to be ſoluble in cold water, and cryſtallizable.

XII. OXALIC ACIDULUM is a ſalt formed by the union of POTASH with *oxalic acid* in proportions in which the alkali is greatly ſuperſaturated by the acid. It is obtained, by evaporation and cryſtallization, from the juice of ſorrel. It [illegible] in ſmall white cryſtals, opake, and needled or lamellated. They are repreſented as being oblong parallelopipeds. The taſte of this ſalt is ſour, poignant, and bitter. It gives a deep red colour to tincture of turnſole and blue paper. 480 grains of this acidulum, afford by diſtillation, [illegible] grains of ſtrongly acid phlegm, and a reſidue of 160 grains of grey ſalt,—from which may be obtained 156 grains of potaſh, with about 4 grains of concrete ſalt in the neck of the retort. This acidulum, when pure, ſuffers no alteration by expoſure to air. It is more ſoluble than tartareous acidulum: 960 parts of boiling water have been found to diſſolve 675 parts of this ſalt. It combines with baryt,

baryt, magneſia, ſoda, and ammoniac; is decompoſed b lime. 100 grains of chalk decompoſe 137 grains of OXALIC ACIDULUM. A precipitate of *calcareous oxalate* is obtained: And the ſupernatant liquor affords carbonate o potaſh. *Sulphuric acid* favours the diſengagement of th oxalic acid from the acidulum by means of heat. Th nitric acid decompoſes the acidulum, and ſeparates the al kali. The metals are liable to be acted upon by this acidulum.

OXALATE OF POTASH, the ſaturated combination of POTASH with *oxalic acid*, is very ſoluble in water, and decompoſable by the action of the mineral acids.

XIII. GALLATE OF POTASH, formed by the combinatio of potaſh with the *gallic acid*, is a ſalt of which the properties have not yet been examined.

XIV. CITRATE OF POTASH is alſo unexamined.

XV. MALATE OF POTASH is known to be a deliqueſcen neutral ſalt.

XVI. BENZOATE OF POTASH has not yet been particularly examined.

XVII. PYRO-LIGNITE OF POTASH is a ſalt decompoſabl by calcareous and barytic earths.

XVIII. PYRO-MUCITE OF POTASH is a ſalt of which th principles cohere in it with conſiderable tenacity.

XIX. CAMPHORATE OF POTASH is cryſtallized in regula hexagons.

XX. CORTATE OF POTASH, the combination of potaſ with the *cortic acid*, is known to be a deliqueſcent neutr ſalt.

XXI. LACTATE OF POTASH is likewiſe a deliqueſcent ſal

XXII. SACCHO-LACTATE OF POTASH cryſtallizes by cooling, and is ſoluble in 8 times its own weight of hot wate

XXII

XXIII. FORMIATE OF POTASH is a non-deliqueſcent, neutral ſalt in priſmatic columns.

XXIV. PRUSSIATE OF POTASH is the combination of potash with pruſſic acid.

XXV. SEBATE OF POTASH is cryſtallizable, and not decompoſable by heat.

XXVI. LITHIATE OF POTASH is a ſalt ſoluble by lime-water, and by ammoniac, in large proportions.

XXVII. BOMBIATE OF POTASH has never been examined.

SECTION SEVENTH.

OF SODA, AND ITS COMPOUNDS.

1. Origin of SODA.

FROM certain lakes anciently famous in Egypt, from th aſhes of ſea-plants growing around the Scottiſh ſhores, from the well known barilla of Spain, by certain proceſſes of a from common ſea-ſalt, is obtained a peculiar alkali, which is diſtinguiſhed by the name of SODA.

2. Its more obvious qualities.

In its phyſical appearance, pure SODA does not materially differ from pure potaſh. The difference of its combinations from thoſe of potaſh, is what beſt diſtinguiſhes its character. It appears naturally in a dry and ſolid form; turns ſyrup of violets green, and deſtroys the colour entirely; melts in the fire by a red heat, and is volatilized by a heat more intenſe; acts upon almoſt all the veſſels in which it can be expoſed to heat; attracts moiſture and carbonic acid gas from the atmoſphere; diſſolves in water with the emiſſion of heat, and of a fœtid lixivious odour; is to be obtained pure from this ſolution, only by evaporation in cloſe veſſels. It combines readily with *ſilex*; and is even better adapted than potaſh, to bring that earth into fuſion It is preferred for this purpoſe by the glaſs-makers. It affinities for the acids, are different from thoſe of potaſ for the ſame ſubſtances. Its intimate nature is unknown It has been ſuſpected to be a combination of an earthy baſ with azote; and magneſia has been ſuppoſed to be th baſe. The difference of the baſes, is ſuppoſed to conſtitut the eſſential difference of nature between SODA and potaſh SODA is employed in making glaſs, in preparing ſoap, i bleaching, &c.

Th

e following are the NEUTRAL combinations of SODA the acids.

3.
Its neutral ſalts.

SULFATE OF SODA is the ſaturated combination of this li with *ſulphuric acid*. It is the ſubſtance, even vulgar-nown in medicine, by the name of *Glauber's ſalt*. It is ined in great abundance from ſea-water, from the wa-of ſalt ſprings, from various other mineral waters. It y be artificially formed by the direct combination of ſo-with ſulphuric acid,—by decompoſing with ſulphuric d, neutral ſalts which have ſoda for their baſe,—by de-npoſing with SODA, terrene and metallic ſalts into which e ſulphuric acid enters as a principle.

It is commonly more or leſs white and tranſparent; cryſ-lized in priſms with ſix unequal and ſtriated ſides ter-inating in dihædral ſummits. The forms of theſe cryſ-s are however ſubject to many varieties. Their taſte is at ſt freſh; but ſoon becomes very diſagreeably bitter. By poſure to fire, this ſalt is quickly liquefied. It produces alteration on blue vegetable colours. From its ſtate of efaction, it ſoon dries and becomes of an opake, white pearance. This firſt liquefaction is ſimply an aqueous ion, accompliſhed by means of its water of cryſtalliza-n. But, if the opake maſs be farther urged by heat; a ond and true *igneous fuſion* will follow; and in the end, e maſs may be volatilized by extreme violence of fire. heſe cryſtals are alſo, in conſequence of the largeneſs of e proportion of their water of cryſtallization, liable to the enomenon of *efflorescence*; that is, to acquire under ex-ſure to the air, a ſort of powdered covering, reſembling oſe ſublimated matters which are improperly denominated *wers*. The drier the ſtate of the atmoſphere; ſo much e more readily does this phænomenon take place on theſe

ſalts

[illegible] and ſome metallic ſ
[illegible], and the ſulph
[illegible] the ſoda, forms w
[illegible]. [illegible] parts of ſulf
[illegible] of ſoda, 27 of ſul
[illegible] is given in medicin
[illegible] ounce and a h
[illegible] remedy.

[illegible] OF SODA is forme
[illegible] *ſulphureous acid* ;
[illegible]

1. [illegible] OF SODA is
[illegible] the *nitric acid.* It
[illegible] regular rhomboidal
[illegible] ſomewhat more bitter t
[illegible] decompoſable by fire. I
[illegible] and then volatilizing,
[illegible] gas azote—leaving i
[illegible] attracts moiſture fro
[illegible] 2 parts of wate
[illegible] to diſſolve 1 part
[illegible] water ſcarce diſſolves this

ies with the baſe. *Alumin* alſo ſeparates the acid,
rms a frit with the alkali. *Baryt* detaches the acid,
aves the ſoda pure. *Potaſh* attracts away the acid.
ntrated *ſulfuric acid* poured upon nitrate of ſoda, diſ-
es the nitric acid with effervеſcence. Neither ſulfate
aſh or of ſoda, nor nitrate of potaſh, produces any
ion on this ſalt. NITRATE OF SODA is not found in
; but is always a product of art. We obtain it—by
rect combination of the nitric acid with ſoda,—by de-
oſing with this alkali, ammoniacal, terrene, and me-
nitrates,—by decompoſing ſulfate of ſoda by the fum-
pirit of nitre,—by decompoſing ſome nitrous ſolutions
etals, with muriate of ſoda. 100 grains of NITRATE
DA contain 28,80 of acid, 50,09 of alkali, 21,11 of
. It is applicable to the ſame uſes as nitrate of pot-
but with leſs of energetic efficacy, on account of its
ger attraction for water.

. MURIATE OF SODA, is better known by the name of
ry or common ſalt. It abounds in nature. In Spain,
ria, Hungary, Muſcovy, Poland, Switzerland, Tyrol,
nd, and many other countries, this ſalt is found in
naſſes in the bowels of the earth. Near ſalt-mines,
equently ſalt-ſprings, from the waters of which, muri-
f ſoda may be obtained by evaporation. The waters
e ocean afford the moſt immenſe ſtores of this ſalt in
e of ſolution, and mingled with a diverſity of other
nd matters of various kinds. From theſe ſea-waters,
xtracted in vaſt quantities for common culinary uſes,
tcoats, *Preſtonpans*, and other places in Scotland; in
parts of *England*; in the ſouthern provinces of France.
ration, ſpontaneous or by artificial fire, affords this
cryſtals, and intermixed with thoſe other ſalts which
are

known to co-exiſt with it in ſea-water. The w Baltic ſea, is ſaid to contain in ſalt $\frac{1}{32}$ pa weight: The water of the Engliſh channel con [illegible] part of its own weight: Between the trop ſea-water is ſaid to have from $\frac{1}{8}$ to $\frac{1}{11}$ part of ſal [illegible] ſalt-water lake in the Ruſſian dominions w [illegible] ſolid with ſalt; and heavy waggons were dri [illegible] as upon ſtrong ice: But, in the year 1757, t [illegible] of the water began to increaſe: And it h increaſed ſo much as now to form within the baſon lake ſtrongly impregnated with ſalt.

The cryſtals of MURIATE OF SODA, are very regula of a ſmaller or a larger ſize, in proportion as the e [illegible] has been ſlow or rapid. They ſtick together [illegible] like cluſters. The taſte of this ſalt is well kn [illegible] diſagreeable. A lively *heat* makes it *decrepitat* [illegible] rarefaction of its water of cryſtallization. [illegible] decrepitation, the ſalt appears in a powder. [illegible] ſtill ſtronger heat, it at length becomes red-h [illegible] Poured, in this ſtate of fuſion, upon a plane [illegible] marble, it forms a ſort of *cryſtal-min*[illegible] Fire n [illegible] this neutral ſalt. Extreme [illegible] of [illegible] volatilizes, but does not deſtroy [illegible] When [illegible] becomes dry, than exhibits any tendency to [illegible] in the atmoſphere. It is eaſily ſoluble in wa [illegible] parts of this fluid will maintain in ſolution, 1 part [illegible] Boiling water diſſolves it not in any greater [illegible] than cold water. A very ſlow evaporation is r [illegible] afford the ſalt from its ſolution, in regular cryſta [illegible] cryſtallization begins on the ſurface of the liquor. [illegible] are terrene ſalts intermingled; theſe may b [illegible] by the addition of SODA. MURIATE OF

f contributing to the fuſion of glaſs. It is uſed to
e exterior ſurfaces of certain coarſe pottery wares,
ngliſh way of *glazing*. *Silice* does not alter this
umin acts with much leſs force on MURIATE OF
an on nitre. But a very ſmall quantity of weak
tic acid is obtained by the diſtillation of alumin
RIATE OF SODA. That *ſel de gabelle* is very impure,
iſtillation of which with *alumin* or rather impure
French manufacturers of *aqua-fortis*, obtain what
ſpirit of ſalt. *Baryt* decompoſes MURIATE OF SODA.
lime nor *magneſia* produces any alteration upon it.
ſh decompoſes MURIATE OF SODA. The *acids* act
diſtinct manner upon this neutral ſalt. Concen-
lphuric acid diſengages from it, *muriatic acid gas*
rveſcence. Woulfe's apparatus is far the ſafeſt and
venient, to be employed in this operation. The
l decompoſing MURIATE OF SODA, forms with its
t mixed acid which is known by the name of *a-*
or *nitro-muriatic acid*. Boracic acid with the help
diſengages the acid from MURIATE OF SODA; form-
the *ſoda*, a new neutral ſalt.

uſes of MURIATE OF SODA are very various. It
r glazing ſeveral ſorts of earthen ware. Glaſs-
uſe it to whiten and purify thin glaſs. In the aſ-
etallic ores, it is employed as a flux to the matter
the ſcoriæ; ſuch as may facilitate the precipitation
metals, and defend them from the contact of the
ere. The SODA is extracted from MURIATE OF SO-
e great way, at *Leith* and at *Newcaſtle*, by a pro-
ch furniſhes bleachers, ſoap-boilers, glaſs-makers,
rs, with this uſeful alkali at an expence conſider-
ller than that by which it was formerly obtained.

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It is an agreeable ſeaſoning almoſt univerſally uſed b
kind in their food. In a ſmall proportion it fav
putrefaction of animal ſubſtances; in a large propo
is found to retard this putrefaction. In caſes of a
and palſy it is put in the mouth, and uſed extern
baths as an excellent ſtimulant. It is in moſt c
powerful diſcuſſive. It is ſtrongly recommended
ful to diſſipate lymphatic tumours, occaſioned by ſcu

IV. Borate of soda is a neutral ſalt formed by
turation or rather ſuper-ſaturation of *ſoda* with *bora*
In the latter ſtate this ſalt is rather denominated
than borate. The countries of the Eaſt, Italy, and
land afford this ſalt. In the Eaſt, it is found in
Thus alſo is it found in Tuſcany. In Holland, it i
ficially prepared. It is ſaid that this ſalt may be p
artificially by mixing in a trough, greaſe, clay, and
in alternate layers; watering this collection at proper
leaving it untouched for ſeveral years; at laſt forming
matters into a lixivium, and ſubjecting that lixivium
vaporation.

However obtained, it appears in its pureſt ſtate i
form of ſix-ſided priſms, having two of the ſides
than the reſt, with trihædral pyramids. It diſplays
varieties of cryſtallization. Its taſte is ſtiptic and u
Containing an extraordinary proportion of soda, it
municates, in conſequence of this, a green tinge to
of violets. By fire, it loſes its water of cryſtalli
ſwells to a conſiderable bulk; aſſumes the form of
porous, and very friable maſs; but remains ſtill un
in its compoſition, ſtill ſuſceptible of being reſtored
lution and a new evaporation to its primary form.
the application of more intenſe heat, we can bring

which it forms a tranſparent greeniſh glaſs. It
alteration from *air*, except an efflorеſcence on
by the loſs of ſome part of its water of cryſtal-
It is eaſily ſoluble in the proportion of 12 parts
1 of BORAX It is obtained by cooling and by
ration, in fine cryſtals. It ſerves as a flux to
ng with it to form a very fine glaſs. It likewiſe
in to vitrefy, but with much more difficulty, and
e imperfectly. We know not well what are the
f this ſalt with baryt and magneſia. Lime has a
inity than ſoda, with this ſalt. If BORAX OF SO-
ne be boiled together, an almoſt inſoluble ſaline
n of lime with boracic acid will be produced.
ears to decompoſe BORAX OF SODA, as well as all
ral ſalts having SODA for their baſe. The acids
ry diſtinct manner as BORAX OF SODA. Sulphuric
itates the pure boracic acid from a ſolution of
SODA. The nitric and the muriatic acids like-
npoſe this ſalt. The *fluoric* and even the *carbonic*
r alſo to be capable of detaching the boracic
e of the alkaline neutral ſalts, whether ſulphuric,
muriatic, acts upon BORAX OF SODA. BORAX is
ility in the arts. It is uſed as an excellent flux
aking, and in the aſſaying of metals. It is uſed
g metals, to make the mixture run, which is de-
the ſolder; and to ſoften the ſurfaces of the
ich are to be united. It was once much uſed in

ATE OF SODA is ſaid by SCHEELE to form a gela-
s,—by other chemiſts, to afford minute, hard,
tals, of an oblong ſquare figure, a bitter taſte,
hat ſtiptic. It decrepitates on burning coals;

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and diſſolves with ſome difficulty in water. It is d poſable by lime-water. The ſulphuric diſengages th oric acid with efferveſcence.

VI. CARBONATE OF SODA is a combination of th *bonic acid* with this alkali. This combination was, probably, the NATRON of the ancients. It is ſuſcepti cryſtallization and effloreſcence. It has an alkaline ous taſte, communicates a green colour to ſyrup of v contains almoſt always the full quantity of carboni neceſſary to its ſaturation and cryſtallization. Its cr are in rhomboidal plates diſpoſed obliquely one ov other, like tiles on the roof of a houſe. By ſlow cr lization, it aſſumes the form of rhomboidal octohæd with pyramids truncated near the baſe, or ſolid dec drons with two acute and two obtuſe angles. It more eaſily than carbonate of potaſh. It loſes ſome part of its acid by heat. 100 parts of CARBONATE OF have been found to contain 16 parts of the acid, 20 of alkali, 64 of water. It is alſo more ſoluble than carb of potaſh. It diſſolves in 2 parts of cold, or 1 part of ing water. It cryſtallizes by cooling. Expoſed to th it readily crumbles down into duſt. It contributes g to the fuſion of vitrifiable earths, and forms with th glaſs leſs liable to alteration than that which is in part poſed of carbonate of potaſh. It has more influenc carbonate of potaſh upon *alumin*. *Baryt*, as well decompoſes this ſalt. A ſolution of it poured into tion of lime, produces a precipitate of chalk. It i poſable by the *ſulfuric*, the *nitric*, the *muriatic* This CARBONATE OF SODA is found in Egypt at th of the earth; abounds but not in complete ſat the aſhes of ſea-weeds; may be artificially form g the ſides of a veſſel with a ſolution of SODA, and then uring in at its mouth, a quantity of *carbonic acid*. It is plied to all the ſame purpoſes with carbonate of potaſh. is much more uſed in manufactories of ſoap and glaſs.

VII. PHOSPHATE OF SODA is a ſalt of an agreeable taſte, med by the union of *phoſphoric acid* with this alkali. It es not eaſily cryſtallize; is often reduced by evaporation o a gummy matter, apt to run into threads; is alſo de-queſcent. There may be obſerved in this matter, needles poſed in radii which indicate an incipient cryſtallization. little more ſoda added to *ſuper-ſaturate* the acid, inſtant- effects a change in the properties of this neutral ſalt. s taſte is now urinous; it turns ſyrup of violets green; cryſtallizes in large parallelograms; it effloreſces in the ir. It does not afford phoſphorus with carbon. It is lled *ſuper-ſaturated phoſphate of ſoda.*

VIII. SUCCINATE OF SODA is a ſalt of which the cryſtals e conſiſtent.

IX. ACETITE OF SODA is the ſaturated combination of *acid* with *ſoda*. It cryſtallizes in ſtriated priſms, like oſe of *ſulfate of ſoda*, and does not attract moiſture from e atmoſphere. It is obtained in regular cryſtals by the poration and cooling of its ſolution. It is decompoſable y fire and by the mineral acids. Diſtilled by a ſtrong t, it leaves a pyrophorous reſidue. It is a powerfully diſ-ive and aperient medicine.

X. ACETATE OF SODA, the ſaturated combination of *ſoda* ith the *acetic acid*, has not yet been examined.

XI. TARTARITE OF SODA is a cryſtallizable neutral ſalt med by the union of *tartareous acid* with this alkali. It well known in medicine by its old name of *ſel de Seig-* e.

XII. PYRO-TARTARITE OF SODA is known to be cryſtallizable and ſoluble in water.

XIII. OXALATE OF SODA is the ſaturated combination of *ſoda* with that *oxalic acid* which is obtained from ſorrel, or from ſugar. In this ſalt the acid exiſts in the proportion of $\frac{1}{3}$,—the ſoda in the proportion of $\frac{2}{3}$. It is ſcarcely ſoluble; but diſſolves beſt in hot water. It turns ſyrup of violets green. The acid in exceſs forms with the ſame baſe, ACIDULOUS OXALATE OF SODA, which is ſcarcely ſoluble.

XIV. GALLATE OF SODA is formed by the combination of *gallic acid* with *ſoda*. But, its properties are hitherto unknown.

XV. CITRATE OF SODA, the ſaturated combination of *ſoda* with the *citric* acid, is alſo a ſalt of unknown properties.

XVI. MALATE OF SODA, the combination of this alkali with the *malic acid*, is a deliqueſcent, neutral ſalt.

XVII. BENZOATE OF SODA has not yet been examined.

XVIII. PYRO-LIGNITE OF SODA remains ſtill to be examined.

XIX. PYRO-MUCITE OF SODA is as little known.

XX. CAMPHORATE OF SODA is a neutral ſalt in irregular cryſtals.

XXI. CORTATE OF SODA, formed by the union of the *cortic acid* with *ſoda*, is a deliqueſcent, neutral ſalt.

XXII. LACTATE OF SODA, is a deliqueſcent ſalt.

XXIII. SACCHO-LACTATE OF SODA is a cryſtallizable ſalt; and is ſoluble in 5 parts of water to 1 part of this ſalt.

XXIV. FORMIATE OF SODA is a neutral ſalt, concerning which we have not yet been able to obtain much information.

XXV. PRUSSIATE OF SODA is a peculiar neutral ſalt, formed by the combination of *ſoda* with *pruſſic* acid.

XXVI. SEBATE OF SODA, the combination of *ſoda* with *ſebacic* acid, is cryſtallizable, and non-decompoſable by heat.

XXVII. LITHIATE OF SODA is the combination of *ſoda* with *lithic* acid.

[illegible] EIGHTH.

[illegible] AND ITS COMPOUNDS.

known to the world in its pure, ſim
[illegible] exhibited in a new form by t
of BLACK and PRIESTLEY. A ne
taken for this pure *volatile alkali.*
is obtainable by diſtillation from th
which is common in the laboratories.
has the ſame tranſparency and elaſticit
lighter than common air; has a pungen
is acrid and cauſtic to the taſte. It i
the blue colour of violets, mallows, an
deep green; but, does not, like the *fix*
deſtroy that colour. It is noxious to an
[illegible] the ſkin, if held in contact with it fo
time. It extinguiſhes inflammation; y
ſuffocating the light of a wax-candl
by porous bodies, ſuch as charcoal, ſpong
one of thoſe elaſtic fluids which heat dilates th
pheric air dilates and divides it. It is readi
by pure water. It has no diſcernible reactio
and ſalino-terrene ſubſtances. *Liquid* AM
properties,—only with inferior ſtrength,—the ſam
the GAS.

Although ſtill arranged, in compliance with prejudice
which we dare not too ſtrongly oppoſe,—among the ſim
ſubſtances; GAS AMMONIAC is, now, moſt certainl
ſhown to be a COMPOUND. The manner in which it ha
been obſerved to act on the flame of a wax-candle, ſeeme

3.
Its compound nature.

o hint, that *gas hydrogen* might perhaps either contaminate t, or enter into its compoſition. PRIESTLEY diſcovered, that the electric ſpark, paſſed through GAS AMMONIAC, rendered its bulk thrice as great as before, and likewiſe diſengaged from it, a quantity of *gas hydrogen*. BERTHOLLET, by a ſubſequent ſeries of experiments, deciſively aſcertained GAS AMMONIAC to be merely a combination of *gas hydrogen* with *gas azote*, rendered aeriform by the preſence of a due proportion of *caloric*. This inference was deduced, particularly from the action of oxygenated muriatic acid upon AMMONIAC, from the decompoſition of *ammoniacal* nitrate in cloſe veſſels, from the reduction of metallic oxyds by means of AMMONIAC. BERTHOLLET concludes AMMONIAC to conſiſt of 6 parts of azote with 1 part of hydrogen, and a certain proportion of *caloric*. *Dr Auſtin* having made alſo ſome valuable experiments upon this ſubſtance, deſcribes AMMONIAC as conſiſting of *azote* to *hydrogen* in the proportion of 121 to 32.

AMMONIAC forms with the *acids*, a peculiar claſs of neutral ſalts, which we are now to enumerate and deſcribe.

4.
Neutral ſalts into which it enters.

1. SULFATE OF AMMONIAC reſults from the ſaturated combination of AMMONIAC with *ſulphuric acid*. In its purity, it appears in the form of needles, which, if carefully examined, are found to be flattened priſms of ſix faces—two very large, and terminating in ſix-ſided pyramids, more or leſs irregular. Sometimes this ſalt appears in quadrangular priſms. Sometimes, in very thin ſquare plates. It is bitter and urinous; light; and friable. It contains in its cryſtals, ſuch a proportion of water as to be liable to liquefaction by moderate heat. At a red-heat, it melts by *igneous fuſion*; and a part of the ſalt is now ſublimated, while another part remains fixed in the veſſels. It ſuffers ſcarce any

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. VIII.

any alteration from *air*. It diſſolves very readily in w 2 parts of cold water diſſolve 1 part of *ammoniacal ſul* boiling water diſſolves of it, a quantity equal to its weight. Its fineſt cryſtals are obtained by inſenſible ſpontaneous evaporation. It acts not on either *alumi* *ſilice*. It is in part decompoſable by magneſia. *Lime*, *b* *potaſh*, and *ſoda* diſengage the AMMONIAC from this ſalt, double decompoſition the *carbonic acid* may be brough detach its baſe. *Nitric* and *muriatic* acids ſeparate a of the *ſulfuric* acid from *ammoniacal ſulphate*. This ſ never found in nature; unleſs, perhaps, in the vicinit volcanoes. Art produces it by a direct combination of *ſulphuric acid* with AMMONIAC,—by decompoſing earth metallic ſalts with AMMONIAC,—by decompoſing nitric, riatic, and carbonic ammoniacal ſalts with ſulphuric SULPHATE OF AMMONIAC is not uſed in medicine or in arts.

II. NITRATE OF AMMONIAC is a product of art, prep by the direct combination of the *nitric acid* with *amm* Its cryſtals are commonly priſms; ſometimes, beau needles reſembling thoſe of common nitre, or of ſulp of potaſh. Its taſte is bitter, pungent, freſh, and urin It is equally friable as ammoniacal ſulphate. By the tion of fire, it liqueſies, exhales aqueous vapours, beco dry, detonizes even in cloſe veſſels, and although no contact with any combuſtible matter. From ſome fine periments by M. BERTHOLLET, it appears that in this inſtance a decompoſition of the AMMONIAC actually t place; and that the nitric acid is, at the ſame time, dec poſed. The hydrogen of the AMMONIAC, combining the oxygen of the nitric acid, forms a portion of wa and there is a large diſengagement of gas-azote devel from both the alkali and the acid. We know not whether this ſalt be ſuſceptible of igneous fuſion: It is diſſipated before it can be brought to the trial. It feebly attracts the moiſture of the atmoſphere. Its cryſtals agglutinate, and form a ſort of clods. It is eaſily ſoluble in water. It combines with ice, and melts it with a conſiderable cold. It diſſolves more readily in hot than in cold water: ½ a part of hot water retains in ſolution 1 part of the ſalt. Spontaneous or inſenſible evaporation is the proceſs for obtaining it in regular cryſtals. It is decompoſable by baryt, lime, and the fixed alkalis. The ſulphuric diſengages the nitric acid from this ſalt with that effervescence which always takes place whenever one acid is expelled out of a neutral ſalt by another acid. Carbonate of potaſh or ſoda decompoſes this ſalt, and is decompoſed by it. The AMMONIAC is ſublimated in a concrete form. AMMONIACAL NITRE is not applied to any uſe.

III. MURIATE OF AMMONIAC the ſaturated combination of AMMONIAC with muriatic acid, is a ſalt to which the ancients gave the name of *ſal ammoniac*, becauſe they were wont to procure it from the vicinity of the temple of Jupiter Ammon on the confines of Libya. It is found in places contiguous to volcanoes. It is prepared in Egypt from camel's dung by a proceſs which was at length made known in Europe. The Egyptian proceſs collects the ſoot of camel's dung which is there burnt as fuel; takes a number of large oval bottles, fills them with ſoot; ſubjects them to heat in an oven; burns under them for three days and three nights a fire of camel's dung; at laſt breaks the bottles, and takes out the ſalt which is found to have been ſublimated into the necks, and the parts contiguous to the necks of the bottles. From *India*, this ſame ſalt

ſalt is procured in truncated cones reſembling ſugar-l
In France, in Scotland, and in England, ſal ammonia
been prepared—by extracting the ammoniac from a
ſubſtances of all kinds, bones, feathers, horns, and
common ſoot,—by forming with the addition of ſulp
acid, SULFATE OF AMMONIAC,—by decompoſing thi
phate of ammoniac with common ſalt which acts upon
double affinity. *Mr Davy* conducts a conſiderable m
facture of this ſalt at Edinburgh. The Earl of Dund
ſuggeſted an ingenious proceſs for extracting AMMO
from pit-coal, which, however, has not proved finally
ceſsful in eſtabliſhment as a manufacture. The Euro
MURIATE OF AMMONIAC is purer than that from the E

This ſalt, is thus obtained in long hexahædral pyram
ſometimes grouped in numbers together, ſo as to ex
the form of feathers. Sometimes, but not often, the
formed in cubic cryſtals, in the middle of the concave,
low part of the ſublimated cake. MURIATE OF AMMO
poſſeſſes the ſingular property of yielding with a ſo
ductility to the fingers or the hammer, and of bein
conſequence of this, not eaſily reducible to a powder.
is wholly volatile; but requires a very ſtrong fire to ſ
mate it. By means, however, of this ſublimation, it is
tained in its greateſt purity, and in a maſs of ſtriated nee
longitudinally joined together. If the heat be too ſtr
what we obtain, is only a ſhapeleſs, thick, and ſemi-t
ſparent maſs. MURIATE OF AMMONIAC is liable to no
teration from the air. It readily diſſolves in water;
parts of cold water diſſolving 1 part of the ſalt. Cold
companies the change; and this in a degree peculiarly
ſible, if the ſalt be mixed with ice. The artificial
thus obtained, is uſefully applied to the cryſtallizatio

tain ſalts, the fixation and preſervation of certain liquids turally very ſubject to evaporation, and other important ſes in chemical practice. Boiling water diſſolves nearly s own weight of this ſalt. The ſalt is cryſtallizable by oling,—but more regularly by ſlow or ſpontaneous evaration. Strong ſolutions of this ſalt, if ſet aſide in a k for a few days, will often be found to exhibit a cryſllization exceedingly like to the diffuſion of the ſprouts and anches of a vegetable. *Alumin* does not decompoſe muate of AMMONIAC. *Magneſia* decompoſes it with difficuly. *Lime* and *baryt* both ſeparate the AMMONIAC even ld from the muriatic acid. By the trituration of MURIATE OF AMMONIAC with lime, the volatilization of the GASMONIAC is immediately effected. Woulfe's apparatus ght to be employed in experiments for the purpoſe of taining this phænomenon. *Potaſh* and *ſoda* both decompoſe MURIATE OF AMMONIAC; diſengaging the AMMOiac in its pure gazeous form. The *ſulphuric* and the *nitric* acids ſeparate the muriatic acid from this ſalt; entering ſelves into combination with the AMMONIAC. Scarcely y of the alkaline neutral ſalts acts upon AMMONIACAL RIATE. Thoſe indeed into whoſe compoſition the carnic acid enters, have power to decompoſe it by double inities. MURIATE OF AMMONIAC is applied to various rpoſes; as a diſcuſſive, in obſtructions and intermittent vers; as a powerful antiſeptic in caſes of gangrene: It is ſed in dyeing, by metallurgiſts in the ſoldering of different metals, by braziers to clear the ſurface of copper ich they are to cover with tin.

IV. BORATE OF AMMONIAC is the neutral ſalt produced by combining AMMONIAC with boracic acid. It affords cryſtals united in a ſtratum, and exhibiting on the ſurface polyhædral

ſalt is procured in truncated cone [illegible] and urinous.
In France, in Scotland, and in [illegible] loſes its cryſtalline
been prepared—by extracting [illegible] action of the external
ſubſtances of all kinds, [illegible] *Lime* diſengages the
common ſoot,—by forming [illegible] known; nor applied
acid, SULFATE OF AM[illegible]
phate of ammoniac with [illegible] alſo a neutral ſalt very lit-
double affinity. M. [illegible] LLANGER agree in repre-
facture of this ſalt [illegible] ſe, but diſpoſed rather to
ſuggeſted an [illegible] as exhaling vapours like
from pit-coal, [illegible] an addition of ſulphuric acid
ceſsful in [illegible]

MURIATE [illegible] NIAC is a neutral, ſaline com-
This [illegible] *carbonic acid.* It does not ex-
ſometh[illegible] ted ſtate; but may be obtained
the for[illegible] ſubſtance by the action of fire. It is
form[illegible] combination of AMMONIAC with
low[illegible] that alkali in the upper part of a
[illegible] fermenting liquor,—by cauſing the car-
[illegible] volatile ſpirit of alkali,—by pouring
[illegible] of which the ſides are wet with AM-
[illegible] water,—by a direct combination of *car-*
[illegible] GAS-AMMONIAC in a veſſel over mercury.
[illegible] the CARBONATE OF AMMONIAC is inſtantly
[illegible] The ſame ſalt may likewiſe be obtain-
[illegible] *ammoniacal muriate* with carbonic neu-
[illegible] a baſe of potaſh or ſoda.

[illegible] of CARBONATE OF AMMONIAC are polyhæ-
[illegible] Its taſte is urinous, but much more faint
[illegible] pure *cauſtic* AMMONIAC. It communicates a
[illegible] to ſyrup of violets. The leaſt heat will en-
[illegible] it. It is therefore almoſt impoſſible to ob-
tain

ryſtallized. It readi-
he inſtant of its
ather more
re than
entirely
if expoſed
acts upon it.
y feeble energy.
of CARBONATE OF
give GAS-AMMONIAC;
from the ſame mixture,
eumato-chemical apparatus.
poſe this ſalt. The *ſulphuric*,
d the *fluoric* acids accompliſh
BERGMAN found by accurate ex-
its of CARBONATE OF AMMONIAC in
r carbonic acid, 40 of AMMONIAC, 12
racic acid, if cold, does not decompoſe
ut, a hot ſolution of *boracic acid* poured on CAR-
OF AMMONIAC, occaſions an efferveſcence, and ex-
the *carbonic acid*. On the perfect neutral ſalts, this
ſtance acts only by double affinities. AMMONIACAL
ONATE is uſed in medicine, as a ſudorific, an anti-hy-
&c. It is mixed for this purpoſe with ſome aroma-
ters. In medicine, it is in general purgative, inci-
diuretic, diaphoretic, and diſcuſſive. It is given in
of a few grains in certain drinks, or in pills mixed
opium.

I. PHOSPHATE OF AMMONIAC is more ſoluble in hot
cold water; affords by cooling, cryſtals not unlike
of alum; is decompoſable by heat, by baryt, lime,
fixed alkalis.

VIII.

[illegible] air, and attracting moiſture from the [illegible]
[illegible] decompoſable by the action of fire, by lim
[illegible] by thoſe which are called the mine
[illegible] loſt in the attempt to cryſtallize it
[illegible]

[illegible] of AMMONIAC, the combination of t
[illegible], but with the *acetic* acid, is a
[illegible] ſalt, not yet ſufficiently known.

[illegible] TARTARITE OF AMMONIAC is a cryſtallizab
[illegible] by combining AMMONIAC with the pu
[illegible] Exceſs of the ammoniac will form
[illegible] ſcarce ſoluble tartareous acidulun.

[illegible] TARTARITE OF AMMONIAC has not
[illegible]

[illegible] OXALATE OF AMMONIAC is cryſtallized in
[illegible] is decompoſable by fire, if ſuperſatur
[illegible] becomes an acidulum, the cryſtals of
[illegible] ſoluble than thoſe of the pure neutral

[illegible] GALLATE OF AMMONIAC is a neutral ſa
[illegible] properties.

[illegible] CITRATE OF AMMONIAC has not been exa

[illegible] MALATE OF AMMONIAC is a deliqueſcen
[illegible]

[illegible] BENZOATE OF AMMONIAC has not yet

XVII. PYRO-LIGNITE OF AMMONIAC has not been examined.

XVIII. PYRO-MUCITE OF AMMONIAC remains alſo to be ereafter examined.

XIX. CAMPHORATE OF AMMONIAC preſents itſelf in needd or priſmatic cryſtals.

XX. LACTATE OF AMMONIAC is known to be a deliqueſt, neutral ſalt.

XXI. SACCHO-LACTATE OF AMMONIAC is a neutral ſalt y eaſily decompoſable by heat.

XXII. FORMIATE OF AMMONIAC is an unknown neutral

XXIII. LITHIATE OF AMMONIAC is a neutral ſalt which be farther examined.

SECTION NINTH.

ADAMANTINA.

BOOK VI. SECT. IX.

1. New earths.

BESIDE the *earths* and *alkalis* which have been, i
book, already enumerated, and traced through thei
eminent, neutral combinations; the reſearches of m
chemiſtry, have lately diſcovered ſome other terren
ſtances, which, ſo far as they are at preſent know
pear to be perfectly peculiar. Theſe are ADAMANTI
adamantine earth;—*Ceylonica* or *earth from Ceylon*;—
or *earth from New South Wales*, contiguous to *Botan*
—*Strontiana* or *ſtrontites*,—*earth from Strontian* in Sco

The following are the moſt remarkable properties
ADAMANTINA.

2. Properties of ADAMANTINA.

It is obtained from *adamantine ſpar*; an oriental
which is known to exiſt,—either in grey ſix-ſided
without pyramids,—or in a whiter variety which is,
contexture, more decidedly ſpathoſe. This ſtone, t
tinguiſhed chemiſt, *Klaproth*, analyſed by—expoſing
fuſion of five hours continuance, in a ſilver crucib
in contact with 15 times its own weight of pure ſo
adding boiling water to the maſs;—filtering it, while t
luted;—and then ſaturating the alkali with an acid,
detaching it, left the earth ſeparate. A part of th
mantine ſpar, remaining ſtill undecompoſed; this he
ted with concentrated, boiling acids. After no few
12 repetitions of this proceſs, the ſtone was complet
com

ed; and was found to conſiſt of 2 parts of alumin part of a peculiar earth,—the ADAMANTINA.

ADAMANTINA, thus obtained, is inſoluble by fuſion kalis; and is not ſubject to be acted upon by acids. re is therefore peculiar; and it cannot be traced h neutral combinations.

SECTION TENTH.

CEYLONICA.

BOOK VI. Sect. X.

1. Whence ceylonica is obtained.

For our knowledge of this peculiar earth, we ar
ed likewiſe to *M. Klaproth.* It was extracted by h
the *jargon of Ceylon*; a ſtone of a pale yellowiſh gre
inclining to red; in *figure*, a four-ſided priſm, te
by two obtuſe pyramids, which are compoſed, each
iſoſceles triangles. Its ſpecific gravity is 4,615; be
greater than that of any other ſtone.

2. Proceſs for detaching it.

In the proceſs, it was ignited; thrown into wate
purpoſe of diminiſhing its coheſion; levigated up
phyry; then fuſed in a ſilver crucible, and in cont
a large proportion of cauſtic fixed alkali. This fu
was treated with water and with muriatic acid; a
part of the proceſs was repeated, till the whole wa
ed by theſe fluids. Carbonate of potaſh was the
to detach and ſaturate the acid. A peculiar precipi
obtained, in conſequence of this ſaturation. Dig
this precipitate with muriatic and with ſulphuric a
forded, at laſt from it, a conſiderable portion of
ſmall portion of nickel and iron, a much larger pr
of a peculiar earth which, on account of its ſolu
acids, remained in ſuſpenſion.

3. Its peculiar properties.

This earth is the pure and genuine CEYLONICA
following are its moſt remarkable properties. Pre
by carbonates, of potaſh, and ſoda, it exhibited no
cence. It exhibited no previouſly known combinati
ſulphuric acid;—but a peculiar ſalt, exceedingly
from ponderous ſpar. It was ſoluble by borax; bu
either ſoda or microcoſmic ſalt.

SECTION ELEVENTH.

SYDNEIA.

A MIXTURE of fine white ſand, a ſoft white earth, ſome lourleſs micaceous particles, and a few black particles, not ike to black lead,—was brought from New South ales, and put into the hands of the late Mr Wedgewood y Sir Joſeph Banks.

Tried with the different acids, this mixture, exhibited th ſeveral of them, no remarkable phænomena. With ncentrated ſulphuric acid, it yielded, by due management, a very ſmall portion of alumin. Muriatic acid, digeſted with it, nearly at a boiling heat, acted on it with equent exploſive burſts, and took up about $\frac{1}{5}$th of the hole quantity. Pulverization and calcination deſtroyed e black colour, and $\frac{1}{4}$th of the weight of the crude mineral, but left it as difficult of ſolution, as at the firſt. The ddition of water to the muriatic ſolution, produced from t, a white precipitate. This white precipitate was found o be ſoluble—only in ſtrong muriatic acid. The nitro-uriatic acid is capable of maintaining the white matter in ſuſpenſion.

This *white matter*, having particularly, theſe relations to uriatic *acid*,—is the SYDNEIA or earth of New South Wales. It is much more fuſible than any of the other imple earths. In a heat of from 142° to 156° of Wedgewood's pyrometer, it was found to melt in contact with alumin, with ſilice, with chalk, with lime, with magneſia,

h baryt, and with carbonate of baryt, in various experi-
nts. Its ſaturated ſolution in muriatic acid, does not
ſtallize, but affords a deliqueſcent maſs, to ſeparate the
d from which, there is required—almoſt a red heat. It
not precipitable either by water or by the pruſſian
ali.

Mr Klaproth, indeed, from e experiments, has been
her inclined to reject the ide f the peculiarity of this
th. The only products which he could by any experi-
nts obtain were *alumin*, *ſilice*, *and iron*, unaccompanied
h any indication of the preſence of any other principle.

SECTION TWELFTH.

STRONTIANA OR STRONTITES.

BOOK VI.
SECT. XII.

t a loſs to diſtinguiſh by what analogy of deriva-
ame of STRONTITES has been impoſed upon that
rrene ſubſtance of which the qualities are here
e enumerated; I ſhould rather prefer for it, the
n of STRONTIANA.

ines of *Strontian* in the ſhire of Argyle in Scot-
'e been found to afford a ſparry ſubſtance; of a
xture; of a greeniſh colour—yet ſometimes quite
; exiſting frequently in hexagonal cryſtals; vary-
ſpecific gravity, from 3,650 to 3,726; inſipid;
800 times its own quantity of water; efferveſ-
acids; yielding in ſolution, carbonic acid in the
n of 30,2 grains out of every 100; by moderate
le to crackle and loſe its tranſparency; by intenſe
ject to loſe 38,79 out of every 100 parts of its
nd to be made unſuſceptible of farther efferveſ-
h acids; in ſolution, capable of changing the col-
per ſtained with the juice of violets or of radiſhes,
l. 100 parts of *Strontian* ſpar, contain 61,21 of
NA; 30,20 of carbonic acid, 8,59 of water.

RONTIANA or earth of STRONTIAN is ſoluble in
times its own weight of cold water. Boiling
wever, diſſolves the earth in a much larger pro-
By cooling, it is depoſited from this ſolution, in
hich are tranſparent, colourleſs, in the ſhape of
lar plates—ſometimes ſquare—more commonly,
ſometimes in parallelopipeds or cubes. In the

centrated, *nitric acid*, u
little capable of reacting
water, this acid diſſolves
rapidity. *Nitrate of ſtronti*
figures, conſiſting of two qu
baſes. Theſe cryſtals ef
queſce in a moiſt one, are
s, and decrepitate by heat
ſoluble in muriatic acid:
ſtrontiana affords the ſalt
s: which are found to con
cryſtallization. Pure *ſtrontiana*
combinations, communicate a r
ſolutions are decompoſed by th
a *ſulphure of ſtrontiana*, when it
with ſulphur in either humid or th
tions are not liable to be deco
or of potaſh.

covery of the exiſtence of this pecu
world is indebted to *Dr Hope* aſſiſt
iſtry in the univerſity of Edinburgh
and obſervations upon it have been fi
amined, and confirmed by that eminent ch
[illegible]

SECTION THIRTEENTH.

GENERAL REFLECTIONS ON THE EARTHS, ALKALIS, AND NEUTRAL SALTS.

BOOK VI.
SEC. XIII.

THUS have we examined the alkalis and the primary ths, with thoſe various ſpecies of *neutral* or *ſecondary* s which are formed by the combination of thoſe earths d alkalis, with the acids. A few general reflexions on e whole may be here added.

I. The firſt thing which naturally ſtrikes us in the train reflexion, is, that the ſimple earths compoſe alone, a y conſiderable part of the ſolid maſs of the globe, yet, e in compariſon, but very rarely found in a ſtate of per- purity. All the ſtrata of rocks, which compoſe as it e, the ſhell of this earth, or the ſupport upon which e vegetable mould is immediately incumbent, are either eous, aluminous, calcareous, or of a character derived m ſome other of the primitive earths. Three of theſe ths are exceedingly common in nature. The others e of more recent diſcovery, and are leſs rarely to be met th.

II. The next thing that in a particular manner, here ges itſelf on our attention, is, that lime and the alkalis pear to be in their origin elaborated by the functions of mals or of vegetables. Lime is never met with, ex- pt in ſituations, where the fair inference is, that it was oduced by the functions of living animal bodies. Even *ſo-*, the mineral alkali, ſeems to have been but accidentally of mineral origin in the famous lake of Egypt: for, we do not generally obtain it at preſent, otherwiſe than from vegetables.

The

The vegetable origin of *potaſh* is ſufficiently known and confeſſed. *Ammoniac* is of animal origin undeniably.

III. It occurs alſo, while we conſider the ſimpleſt of theſe ſubſtances, that ſince *ammoniac* the moſt ſubtile of them has been aſcertained to be a compound, the other alkalis, and perhaps even ſeveral of the earths may be, ſooner or latter, reduced alſo to their conſtituent principles. Since ſeveral of the earths are ſo much more abundant than the reſt in nature; is it not reaſonable to expect, that perhaps thoſe which exiſt in ſo much ſmaller quantity, may in the end, be traced to a perfect identity of qualities with the more abundant ones?

IV. That law by which totally new ſubſtances are produced from the union of the acids with the earths and the alkalis is a very remarkable one. How immenſely numerous are the new bodies thus formed! It is but recently, that chemiſtry, having become acquainted with the exiſtence of a multitude of acids, before unknown, has been enabled to trace the neutral ſalts through all their diverſity. Add to that portion of the materials of this globe, which is made up of acids, alkalis, and earths, that alſo which is compoſed of the neutral combinations of theſe primary ſubſtances; and we ſhall find the ſum to comprehend by much the larger part of the whole. It is, comparatively ſpeaking, but on a few occaſions, that the more elementary ſubſtances are to be found in a ſtate remote from combination. We find them moſt commonly in a neutralized form. There are indeed many aggregate mixtures in which no perfect, chemical combination has place. But except in the caſe of theſe mixtures, neutral ſalts are what moſt uſually preſent themſelves to our obſervation throughout external nature.

BOOK VI. SEC. XIII.

Of thoſe ſubſtances which chemiſtry furniſhes for
es of human life, the greater number are neutral
The properties and relations of theſe ſaline bodies
e therefore to be made in a much more eminent de-
han they have hitherto been, the ſubjects of chemi-
eſtigation. When thoſe which are formed by the
ble and animal acids, ſhall be more perfectly known,
be hoped, that there may be much derived from
or the immediate uſes of the arts.

ELE-

ELEMENTS OF CHEMISTRY.

BOOK SEVENTH.

OF THE METALS.

SECTION FIRST.

OF ARSENIC, AND ITS COMPOUNDS.

1.
Metals in general.

AMONG the primitive ſubſtances which become known to the chemiſt in his ſurvey of material nature, are a conſiderably numerous claſs which on account of ſome properties in which they all agree are known by the common name of METALS. Theſe ſubſtances are all more or leſs *ductile* under the hammer; liable to be *indurated* to *brittleneſs* by the ſame action; either exiſting in a ſtate in which they are *combined with oxygen*, or elſe capable of being brought into that ſtate, by the operation of fire, and the preſence of other bodies in which oxygen exiſts in no very tenacious combination; capable of diſplaying in their unoxydated ſtate, a brilliancy and luſtre more or leſs ſtriking, and which are diſtinguiſhed by the peculiar appellation of *metallic*. They are found in the bowels, or ſometimes at the ſurface of the earth; either alone, or combined or contaminated [illegible] The [illegible] manganeſe, nickel, [illegible]

[illegible] It [illegible] and it [illegible] Sometimes it [illegible] it has the name of [illegible] when expoſed to heat on [illegible] which have the ſmell of garlic. It is [illegible] It is often combined with ſulphur; [illegible] called orpiment or realgar. In orpiment it [illegible] maſſes, ſometimes [illegible] : *Realgar* is of a red co[illegible] tranſparent; ſometimes cryſta[illegible] needles. *Miſpikel* or arſenical pyrites, is a w[illegible] ore of arſenic, ſometimes cryſtallized in cubic cryſtals, [illegible] without any determinate form. *Arſenic* is [illegible] found intermingled among the ores of cobalt, antimony, tin, iron, copper, and ſilver. The mines of cobalt, in Saxony, and at Andrarum in the province of Schonen in Sweden; thoſe of St Marie aux mines, in France; the vicinity of Jinto in New Spain, and the edges of the volcanoes of Mount Veſuvius; afford this metal in conſiderable abundance. It is chiefly from Saxony, we obtain, that which is ordinarily preſented to our uſe by commerce.

Theſe ores of ARSENIC, are to be *aſſayed* immediately after being taken from the mine. In the *aſſay*, the ore muſt be

3. Purification of the ores of arſenic.

ſhed ; roaſted by expoſure to heat in a crucible or a retort, till the ore become red-hot, and ceaſe to ex- vapours ; next melted by the aſſiſtance of a preparation by the miners, black flux, and of a little muriate of after this fuſion, permitted to cool ; in doing which, have been thoroughly fuſed, it takes the form of a lump or button,—all the metal running together, e from the ſcoriæ or droſs,—and theſe appearing in compact, uniform, vitreous maſs, covered over with a of melted marine ſalt. The metallic button, weigh- and compared with the original weight of the ſpeci- will ſhew in what proportion the metal exiſts in the The ores of ARSENIC and of other metals, are purifi- the *great way*, or in *manufacture*, nearly by this ſame ſs, repeated with the fires, the veſſels, the quantity of res, and of the fluxes, all in a much more conſidera- proportion. There are in arſenic, ſome peculiarities make it to be obtained pure—by a part only—of the proceſs. If expoſed to fire in cloſe veſſels, it is ſu- d, but not decompoſed. In this change, it attracts from the vital air decompoſed around it ; and is ediately converted into an oxyde. If ſlowly ſublimat- it is cryſtallized in regular tetrahædral figures.

4. Characters of pure metallic arſenic.

Pure ARSENIC, commonly called *regulus of arſenic*, is of kiſh grey colour, reflects the colours of the rainbow, very ponderous and friable. It does not act in a ſenſible er on combuſtible bodies. Expoſed to the air it be- ſenſibly black. It does not ſuffer from the attacks water. The *ſulphuric acid*, even when concentrated, produces no immediate effects on arſenic. But if the me- and the acid be boiled together in a retort ; the acid give out ſulphureous acid gas, a little ſulphur will be ſublimed,

[illegible] the ARSENIC will be oxydated, th
[illegible] The *nitric acid*, quickly oxydates ARS
[illegible] is produced by the *muriatic acid*. I
[illegible] caſt on *oxygenated muriatic acid*, burns
[illegible]

[illegible] combined by combuſtion, or by the applica
of ſome of theſe ſubſtances above mentioned, with oxy
—forms what is properly denominated OXYDE OF AR
but was formerly called CALX OF ARSENIC. This ſubſt
commonly appears from artificial preparation in a w
cryſtalline powder in which it forms what is ſometi
named *flowers of arſenic*. At times, it is preſented to
commerce, in a white, ponderous, vitrefied, and ſtrat
maſs. It is alſo cryſtallized into very tranſparent,
triangular, ſolid figures, with truncated angles: But, t
cryſtals very ſoon loſe their tranſparency. This OXYD
reducible back into the perfect metallic ſtate by expo
to heat in a paſte with black *ſoap* of which the *alkali*
occaſion the abſtraction of the oxygen from the meta
oxyde, in order to the combuſtion of its *oil*. *Vitrefied*
YDE OF ARSENIC, if expoſed to the air, loſes its tranſpar
cy, acquires ſomewhat of a lacteous appearance, and
dergoes a ſort of effloreſcence. It is eaſily diſſolved in
air. Cold water diſſolves rather more of it than does
water. The ſolution ſlowly evaporated, affords yellow
cryſtals in tetrahædral figures, more or leſs regular.
readily unites with *earths* by fuſion; becomes fixed w
them; and accelerates their vitrification. The *alk*
when pure, readily diſſolve this ſubſtance. *Liver of arſ*
is prepared—by boiling powdered oxyde of arſenic in liq
of nitre, or in a ſolution of cauſtic potaſh: It form
thickening, brown, gelatinous fluid; is not ſuſceptib
cryſtallizati

zation; becomes hard and brittle; is liable to de-
; is ſoluble in water; precipitates when diſſolved,
own flakes; when urged by a ſtrong fire, loſes its
; is decompoſable by acids. The ſolution of po-
ill afford with oxyde of arſenic, a ſimilar mixture.
OF ARSENIC is ſoluble in concentrated *ſulphuric acid*,
ile the acid is hot. *Nitric acid*, aſſiſted by a mo-
heat, likewiſe diſſolves this OXYDE in a pretty large
ion. The *arſeniac acid* to be hereafter deſcrib-
ms to be a product of the action of *nitric acid* on
OF ARSENIC. The *muriatic acid* aided by fire, diſ-
his OXYDE: If cold, this acid is entirely incapable of
n arſenic. Arſenic mixed with nitrate of potaſh,
es on the coals, and is found to have been by this
oxydated. OXYDE OF ARSENIC, mixed with nitrate
ſh in equal parts, affords by diſtillation, *ſpirit of ni-*
ery red vapours. With ſulphur, in various propor-
xyde of arſenic forms *realgar* and *orpiment*.

ARSENIC is ſuſceptible of receiving into combination 6. Arſeniac acid.
a larger proportion of oxygen, than that by which
mmonly oxydated. In this ſuperoxydated ſtate, it
forms a peculiar acid. The nitric acid contributes
ſt effectually to the formation of the ARSENIAC
ecauſe nitric acid reſigns its oxygen with extra-
y readineſs. OXYDE OF ARSENIC is alſo converted
SENIAC ACID by diſtillation with the *oxygenated*
acid, which is well known to be little tena-
a part of its oxygen. The ARSENIAC ACID thus
is of a ſtronger taſte than common OXYDE OF AR-
It is fixable by fire, while the oxyde is ever liable
limated. It melts into a tranſparent glaſs, and

ſublimed, and the ARSENIC [illegible] me matters. It
not diſſolved. The *nitric* [illegible] municates a faint
The ſame effect is produ[illegible] expoſed to the air,
dered ARSENIC caſt on [illegible] n ſcaly fragments,
a white flame. [illegible] diſſolves in two parts

5. Oxyde of arſenic.

ARSENIC comb[illegible] lime; with baryt alſo
of ſome of theſ[illegible] the alkalis, it forms
—forms wh[illegible] by lime. It may be
but was fo[illegible] *ammoniacal nitrate* with
common [illegible] *potaſh* is the moſt remarkab
cryſtal[illegible] combination of this acid with
nam[illegible] heat; is unaltered by air;
con[illegible] the pure metallic oxyde; is
m[illegible] acids, only in the way of doub
[illegible] of iron is mixed with a
[illegible] decompoſes alſo nitrate of ſoda by
[illegible] products are, *arſeniate of ſoda*
[illegible] power of decompoſing, in its form
[illegible] ate, has been already mentioned.
[illegible] alkaline muriates.

[illegible] gravity of ARSENIC varies from that
[illegible] the metallic ſtate to that which belon
[illegible] ed. The following are its different
[illegible] ſtates: Pure metallic arſenic 8,308:
[illegible] arſenic 5,000: white oxyde of arſenic 3,70
[illegible] 3,391.

[illegible] be forgotten, that in all ſtates of its oxy
[illegible] of ARSENIC is to be conſidered as more or
[illegible] In thoſe ſtates in which it contains the
[illegible] is a weak acid; in that in which it contains
[illegible] oxygen, it is a ſtrong acid.

ARSE

ARSENIC is uſed in the art of dyeing, and in others of arts. OXYDE OF ARSENIC forms a very powerful poiſon. careous ſulphure, impregnated with iron, as it attracts YDE OF ARSENIC into the new combination of *orpiment*, he beſt counterpoiſon that can be in this caſe employ-. *Arſeniate of potaſh* is uſefully employed in the arts.

SECTION SECOND.

OF MOLYBDENA, AND ITS COMPOUNDS.

a of
dena.

MOLYBDENA is a peculiar metallic ſubſtance which was firſt diſcovered by *Mr Hielm*. It conſiſts, in its ſpecimens, of hexagonal, ſcaly laminæ of various ſizes, and ſcarcely adhering together. It ſpots the fingers, and leaves blueiſh or ſilver-grey marks upon paper. When it is reduced to a powder, it has in this form a blueiſh gliſter. It may be cut with a knife. It is ſtill not the pure metal, but only a compound of the pure metal with ſulphur. To obtain from this compound, the pure molybdena, is a taſk of the utmoſt difficulty. Except *Hielm* and *Pelletier*, ſcarcely any chemiſts have been ſucceſsful in the attempt. By *Pelletier* it was obtained in a friable blackiſh, agglutinated matter of a metallic luſtre, which, viewed through a magnifier, appeared to conſiſt of ſmall, round, grey, ſparkling grains. When heated in the air, it is converted into a white, volatile oxyde, cryſtallizable by ſublimation into ſparkling needled priſms. The metal is eaſily oxydable by nitric acid. With heat it may be diſſolved by the alkalis. It may be mixed with lead, copper, iron, and ſilver. It combines with ſulphur, to form *ſulphure of molybdena*,—improperly named *potelot*. This *ſulphure of molybdena* heated in a crucible with another crucible covering it, affords white, ſparkling, needled cryſtals, reſembling that matter which is called *ſilver flowers of antimony*. The ſaline earths and the fixed alkalis, if melted with *ſulphure of molybdena*, diſſolve both the ſulphur and the metal. The *ſulfuric acid* reduces the metal to an oxyde

oxyde, and diſengages a quantity of ſulphureous acid, in the way of ebullition. The acid of arſenic, if diſtilled with *ſulphure of molybdena*, loſes its oxygen: but the new products conſiſt of ſulphureous acid gas, *orpiment* or ſulphure of arſenic, and molybdic acid. 30 ounces of diluted nitric acid, diſtilled with 1 ounce of molybdena at 5 different times, 6 ounces of the acid at a time, afford a great quantity of nitrous gas, and a reſidue of white powder, which laſt ſubſtance waſhed and edulcorated affords 6½ drachms of pure molybdic acid, beſide a product of ſulphuric acid which is carried away by the water when the molybdic acid is waſhed. A decompoſition of the nitric acid employed, muſt, no doubt, take place in this inſtance.

2.
The molydic acid, &c.

MOLYBDENA thus oxydable in different ways, and indeed liable to appear oftener in an oxyde or in a mixture, than in its own pure and genuine form; is by oxydation, reduced abſolutely to the ſtate of a perfect acid. The MOLYBDIC ACID appears in the form of a white powder. Its taſte is faintly acid and metallic. Heated in a ladle or in a crucible with acceſs of air, it volatilizes in a white ſmoke, ſubject to be condenſed into needled cryſtals, and to be in part fixed on the ſides of the crucible. Even after edulcoration, it ſtill retains a portion of ſulphureous acid. It is ſoluble in boiling water, in the proportion of a ſcruple of the acid to 20 ounces of water. This ſolution is ſingularly acid, and almoſt metallic. It reddens tincture of turnſole, decompoſes a ſolution of ſoap, and precipitates alkaline ſulphures, the mixtures of ſulphur with the alkalis. Concentrated ſulphuric acid, with the aid of heat, diſſolves a large proportion of the MOLYBDIC ACID. The ſolution, when cool, becomes thick, and aſſumes a beautiful colour. Intenſe heat, received in a retort, volatilizes the ſulphuric acid, leaving the MOLYBDIC ACID dry in the bottom of the veſſel. The *nitric acid* does not act at all on the MOLYBDIC. The common *muriatic acid* diſſolves a large proportion of this acid. This ſolution, if diſtilled to dryneſs, affords a dark blue reſidue, which, if urged with heat, is ſublimed, one part of the ſublimate being white, the other blueiſh. The ſublimate is apt to deliquiate, and tinges metals. The muriatic acid is oxygenated, when it paſſes into the receiver. In this operation, a part of the molybdic acid is evidently deprived of its oxygen by the muriatic acid, and in conſequence of this, is reduced back into the genuine metallic ſtate. Aſſiſted by heat, the MOLYBDIC ACID decompoſes the alkaline nitrates and muriates, and combines with their baſes, to form neutral ſalts. It alſo diſengages the carbonic acid from the three alkalis. Fixed alkalis make the molybdic acid more ſoluble in water, and hinder it from being volatilized by heat. *Molybdate* of potaſh is precipitated by cooling, in ſmall granulated cryſtals. It may be alſo ſeparated from its ſolvent by the ſulphuric and muriatic acids. *Barytic* ſulphate and nitrate, are decompoſed by the MOLYBDIC ACID: and there is formed upon this occaſion, a *barytic molybdate* which is ſoluble in water. The MOLYBDIC ACID effects a partial decompoſition of ſulphate of potaſh; diſengaging from it by a ſtrong heat, a little ſulphuric acid. This acid diſſolves ſeveral metals, becomes blue by the loſs of its oxygen, precipitates various metallic ſolutions, has been found by *Klaproth*, combined with lead in the yellow ſpathoſe ore of that metal.

SEC.

SECTION THIRD.

TUNGSTEN, AND ITS COMPOUNDS.

1
Origin of tungſten.

TUNGSTEN is a metallic ſubſtance, for the knowledge of which we are indebted to experiments made within theſe laſt twenty years, by the great Swediſh chemiſts, BERGMAN and SCHEELE, by *Crell*, and by Meſſrs *D' Elhuyar* and *Angulo* of Spain. Nature affords this ſubſtance only in a combination with lime, which has been denominated *lapis ponderoſus*, and to which chemiſts now give the name of native *tunſtate of lime*. This particular combination has been found in the iron mines of Bitſberg, in the tin-mines of Schleckenwalde in Bohemia, at Sauberg near Ehrenfreenderſdorf, and elſewhere. It appears in compreſſed hexahædral priſms; it has the metallic luſtre; its fracture is foliated; it may be cut with a knife. It contains in the Cwt. frequently 68 parts of tunſtic acid, with 30 parts of lime, in other inſtances 22 parts of black oxyde of manganeſe, 12 of oxyde of iron, 64 of tunſtic acid, and 2 of quartz. This ſpecimen was melted with carbonate of potaſh in the proportion of one part of the tunſtate of lime, to four parts of the carbonate of potaſh. The mixture was afterwards lixiviated, when the water diſſolved the tunſtate of potaſh. The nitric acid being then applied, precipitated the tunſtic acid in a yellow powder. This precipitate put into a crucible with charcoal, and then urged with fire, afforded a metallic button conſiſting of a ſmall number of globules.

2.
Character of pure tungſten.

The metal thus obtained from native *tunſtate of lime*, poſſeſſed the following properties. Its ſpecific gravity was a-

bout

OOK VII. ECT. II.

ſulphuric acid, leaving the MOLYBDIC ACID
tom of the veſſel. The *nitric acid* does no
the MOLYBDIC. The common *muriatic*
large proportion of this acid. This ſoluti
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BOOK VII. SECT. III.

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SECTION FOURTH.

OF COBALT, AND ITS COMPOUNDS.

BOOK VII
SECT. IV.

1
Origin and varieties of the ore of COBALT.

COBALT is a metal which has never yet been found p in nature. But, we find it almoſt always in an oxyde, a in combination with ſome other metal or metallic oxy It is often united with arſenic in a ſolid, grey, ponder ore, ſomewhat brilliant and granulated; which gives f with ſteel, becomes black by expoſure to heat, diſſolves the nitric acid with effervescence, and forms with the m riatic acid, a ſympathetic ink. It appears occaſionally i ſolitary oxyde; which is commonly of a blackiſh grey c our, ſometimes reſembles lamp-black, is generally fri and pulverulent; ſtains the fingers, and when compact, e hibits at its fracture, roſe-coloured ſpots; ſometimes r ſembles the ſcoriæ of glaſs; and is often mixed with ma tial ochre. In combination with the arſeniac acid, an ore of cobalt, has been diſtinguiſhed as *flowers of cobalt, red, roſe-coloured, or coloured like peach-bloſſoms*: It owes its colour to the arſeniac acid combined in it: It is either in maſſes, in a powder, in a ſtriated efflorescence, or in four-ſided priſms with ſummits of two faces. In fire it gradually loſes its colour, while the arſeniac acid is diſengaged. Another ore of COBALT, is that *ſpecular cobalt ore* in which iron and ſulphuric acid exiſt in combination with this peculiar metallic ſubſtance. It is white or grey, very brilliant, the richeſt of all cobalt ores, commonly gives fire with ſteel. COBALT is alſo combined with ſulphur, arſenic, and iron in the *white* or *grey ore of cobalt*; which is of a whitiſh grey colour;

lour; is cryſtallized in complete or truncated cubes ſo as to form ſolid figures of 14, 18, or 26 faces; is ſparry and lamellated at its fracture; on its ſurface ſometimes exhibits dendrites in leaves reſembling fern; is lighter in its ſpecific gravity than the preceding ſpecies; and exhibits almoſt always a red effloreſcence on its ſurface.

2.
Aſſay and extraction of COBALT ores.

Ores of COBALT are aſſayed by pounding, waſhing, roaſting, melting with three parts of *black flux* and a little marine ſalt. Cooling, after the laſt of theſe proceſſes, produces the metal in a button at the bottom of the crucible. Some modern mineralogiſts have recommended nitric acid, as the fitteſt matter for the aſſay of cobalt ores: Others adviſe the uſe of 3 parts of potaſh, with 5 of powdered glaſs. In operations in the great way, theſe ores are roaſted in a furnace terminating in a long flue which is horizontal. The COBALT here ſeparated—from the arſenic which is ſublimed into the flue,—and from whatever biſmuth it might contain which falls to the bottom of the furnace,—is obtained by itſelf in a dark grey oxyde which is named *zaffre*. This *zaffre*, if expoſed to intenſe heat, is thus fuſible into a dark-blue glaſs known by the name of *ſmalt*. Grinding and dilution reduce this *ſmalt* to what is called *ſe azure*. Subſequent purification brings it to the ſtate of what is called *azure of four fires*, which is uſed in ſeveral of the arts for communicating a blue colour to metals, ſes, &c. The *zaffre* of commerce, if melted with thrice its own weight of black flux, a little tallow, and a little marine ſalt, affords COBALT in its genuine metallic ſtate.

3.
Characters of pure COBALT.

Pure COBALT, thus obtained, is of a reddiſh white colour, a fine cloſe grain, very brittle, eaſily reducible to a powder. In the hydroſtatic balance, it loſes about $\frac{1}{8}$th of its weight. BERGMAN ſtates its ſpecific gravity at about

7,700.

SECTION FOURTH.

OF COBALT, AND ITS COMPOU

BOOK VII
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in quadrangular ſolids, reſembling the volutes of Gre-
n architecture. It has ſcarcely any taſte or ſmell. It
n nature uſually diſpoſed in triangular plates, one over
other. Its cryſtals are ſometimes very regular octohæ-
ons.

4.
Its relations.

BISMUTH is inalterable by the contact of light. It is
tremely fuſible, and *melts* long before it be red-hot. In
ſe veſſels it is eaſily ſublimated. By cooling, it cryſtal-
es into Grecian volutes. It cryſtallizes very readily.
ld for ſome time in fuſion, in contact with air, it ſoon
quires a pellicle on its ſurface, which changes into a
eeniſh grey or brown oxyde, called *cinder* or *calx of* BIS-
UTH. Made red-hot, it burns with a faint and ſcarcely
ſernible blue flame. The oxyde is evaporable in the
m of a yellowiſh ſmoke, which is condenſed by cooling
o a powder called *flowers of biſmuth.* Expoſed by itſelf,
hout flux, and not in immediate contact with carbon,
fire, it does not ſublimate, but melts into a greeniſh
ſs. Expoſed in a bowl of unburnt porcelain, to the
at of a furnace, BISMUTH has been obſerved to run
rough a crevice in the crucible, in a yellowiſh glaſs,
hile that which remained in the crucible, was a glaſs of
dull violet colour. By expoſure to *air*, BISMUTH is ſome-
at tarniſhed; and a whitiſh ruſt is conſequently form-
on its ſurface. It combines not with the earths, nor
fers any injury from the attacks of water. It commu-
cates a greeniſh yellow hue to thoſe glaſſes into the com-
ſition of which it enters. BISMUTH brought into con-
t with concentrated ſulphuric acid, decompoſes that a-
l in part: ſulphureous acid gas is evolved; and a *ſul-*
phate

OOK VII.
ECT. V.

phate of biſmuth, with ſome portion of OXYDE OF BISMUTH are formed. The *ſulphate of biſmuth* thus obtained, is decompoſable by fire, by the ſalino-terrene ſubſtances, by alkalis, and even by water applied in ſufficient quantity. This *ſulphate of biſmuth* appears in ſmall deliqueſcent needled cryſtals. *Nitric acid* diſſolves BISMUTH with amazing rapidity; and is itſelf robbed of its oxygen, while the metal undergoes oxydation. *Nitrate of biſmuth* is cryſtallized in tetrahædral priſms, ſomewhat compreſſed, and with two obtuſe trihædral pyramids, the ſides of which are a rhombus and two trapezia. By ſlow evaporation this ſalt may alſo be obtained in very large flattened rhomboids, perfectly ſimilar to the well known calcareous ſpar of Iceland. It detonizes with a faint noiſe into reddiſh ſparks, melts, ſwells, and leaves a greeniſh yellow oxyde which cannot be reduced without the addition of ſome other ſubſtance. Expoſed to the air, it loſes its tranſparency, and the water of its cryſtallization eſcapes. When an attempt is made to diſſolve it in water, the ſolution becomes white and milky, and gives a precipitate of *oxyde of biſmuth*. A ſimilar precipitation is effected, upon pouring the nitric ſolution of BISMUTH into water. The precipitate proves to be what has received the name of *white paint or magiſtery of biſmuth*. 100 grains of BISMUTH diſſolved in *nitric acid*, afford 113 grains of precipitate. *Muriatic acid* concentrated, and long digeſted over biſmuth, or rather muriatic acid diſtilled upon biſmuth, produces an exhalation of a fetid odour, and a reſidue which proves to be a *muriate of biſmuth*. It is a ſoft, fuſible, deliqueſcent ſalt, decompoſable by water, and improperly termed *butter of biſmuth*. BISMUTH is *oxydable* without any ſenſible detonation, by common nitre. It does not decompoſe ammoniacal muriate.

Its colour is altered by *gas-hydrogen*, to a violet hue.
r unites with BISMUTH by fuſion, into blueiſh grey,
kling, tetrahædral needles, which in their colours, re-
le pieces of the moſt beautiful antimony.

5. The oxyde of biſmuth.

OXYDE OF BISMUTH is the combination of this metal
the baſe of gas-oxygen. It is ſometimes native. In
er inſtances it is formed by the ſeveral artificial means
ich have been enumerated. The grey or brown, ſub-
ated or vitreous oxydes of this metal, cannot be re-
ed without the addition of a third matter. But, gas-
drogen, carbon, and all organic combuſtible matters con-
ing theſe ſubſtances, decompoſe OXYDE OF BISMUTH, by
racting its oxygen, and leaving the metal ſimple and a-
e. This OXYDE decompoſes ammoniacal muriate. A
at proportion of gas-ammoniac is diſengaged in this o-
ation; and there is a reſidue of metallic oxyde combin-
with muriatic acid. This fact ſeems to repreſent *oxyde*
iſmuth, as in its nature not very different from ſaline
ſtances.

6. Its uſes.

BISMUTH is uſed by workers in tin, to communicate a
per hardneſs to this metal. It may be uſed inſtead of
, for the cupellation of metals. It is believed to be ca-
le of operating with a dangerous efficacy upon the ani-
economy. The OXYDE is uſed under the name of
e paint, for whitening the ſkin. But, it is exceedingly
e to be diſcoloured, particularly by fœtid effluvia, and
ll ſtrong-ſmelling matters.

[illegible] made acquainted
[illegible], combined with
[illegible] like the [illegible] of
[illegible]
[illegible] ny, and is foun
[illegible] in Dauphiny. It
[illegible] Its cryſtals are o
[illegible] from its ores by the f
[illegible] to drive off ſome pa
[illegible] it contains. This ro
greeniſh oxyde. The o
[illegible] of black flux and mu
ſubſtance which was once
[illegible] which farther proceſſes
the utmoſt purity. Man
[illegible] ſolutions with lime a
[illegible] genuine NICKEL in a ſtate in
[illegible] ſuſpected that it might
[illegible] tion of iron, but in which
[illegible] conſider it as being undoubted
[illegible]

[illegible] diſplays a granulated fractur
[illegible] as water: it is conſiderably d
[illegible]; and not much eaſier

arts of concentrated ſulphuric acid, if diſtilled on one part of NICKEL in its metallic ſtate; yield as products, a quantity of ſulphureous acid gas, and a greyiſh reſidue, which by ſolution in water, becomes of a beautiful green colour, and affords at laſt foliated cryſtals of an emerald colour. NICKEL detonizes with nitre, and is oxydated by the detonation. Ammoniacal muriate is in part decompoſed by NICKEL. With ſulphur, this metal unites by fuſion. A ſort of hard mineral is now formed, with ſmall ſparkling facets, and of a yellow colour. By expoſure to a ſtrong heat in the open air, this mineral is made to crackle and ſend out luminous ſparks. A ſeries of fuſions and calcinations are requiſite to ſeparate NICKEL from ſulphur. With arſenic NICKEL unites with great tenacity. It combines with *cobalt* even more intimately than with arſenic; and can hardly be entirely ſeparated from either the one or the other of theſe ſubſtances, With BISMUTH, too, it is ſaid to form a brittle, ſcaly mixture.

3. Its oxyde.

The combination of nickel with oxygen, whether native or artificial, is readily ſoluble in nitric acid. A *nitrate of nickel*, cryſtallizable into rhomboidal cubes, is ſaid to be the product. OXYDE OF NICKEL fuſed with borax, communicates to the borax an hyacinthine colour. The OXYDE OF NICKEL produced by the detonation of the metal with nitrate of potaſh, communicates to glaſſes a deep hyacinthine colour, which, however, they are liable to loſe by fuſion.

NICKEL and its OXYDE have not hitherto been applied to any uſe.

SECTION SEVENTH.

OF MANGANESE AND ITS COMPOUNDS.

BOOK VII. SECT. VII.

1 Origin of mangane∫e.

MANGANESE is found in nature, in many different ores. Sometimes it is cry∫tallized in pri∫ms tetrahædral, rhomboidal, or ∫triated, and ∫eparate from one another, or in pri∫ms bundled together. It is cry∫tallized too in ∫mall needles in a ∫tellated arrangement. It appears in a black eﬄore∫cence, which ∫oils the fingers like ∫oot. It is ∫ometimes found in a beautiful, needled eﬄore∫cence re∫embling black velvet. It is found at times in a compact ∫hapele∫s ore, of a black-grey colour, generally with cavities, but very ponderous. There is a ∫parry MANGANESE found in the iron mines of Klapperud at Fre∫ko in Dahl-land. There is a native MANGANESE in metallic globules. It has been di∫covered by SCHEELE in a∫hes of vegetables: and the alkalis are perhaps often impregnated with it.

2. Characters of the pure metal.

Pure MANGANESE is of a greyi∫h white colour, a fine granulated texture, a ∫parkling white fracture. It is brittle, not fu∫ible without great difficulty, in a very ∫mall degree ela∫tic. It is the only metal combu∫tible in the open atmo∫phere; and by combu∫tion it in∫tantly changes its colour; becoming, from whitei∫h, an ab∫olutely black powder. But a ∫mall degree of heat, ∫uch as the temperature of the atmo∫phere will frequently afford, is requi∫ite to this *oxydation* of MANGANESE. To avoid it, the pure metal mu∫t be kept in alcohol. The genuine metal cannot be obtained from the oxyde without great difficulty, or without a proce∫s, in which the utmo∫t inten∫ity of heat muſt be employed, and in which it is uncertain whether or not the common flux be materially uſeful.

3.
Its relations.

The mutual attractions between MANGANESE and the baſe of gas-oxygen, are apparently more eager than thoſe between oxygen and any other metal. Its reaction with the earths and the ſalino-terrene ſubſtances has not as yet been examined. As little are we acquainted with the relations between MANGANESE and the alkalis. *Sulphuric* acid relinquiſhes its oxygen to this metal. *Nitric* acid in the ſame manner diſſolves manganeſe; and the ſolution is attended with an emiſſion of red vapours of *nitrous gas*. The *muriatic* acid likewiſe diſſolves and oxydates MANGANESE. *Fluoric* acid diſſolves but a very little of this ſubſtance. *Carbonic* acid, by digeſtion with cold, diſſolves a ſmall portion of MANGANESE. MANGANESE can never be entirely purified from its iron. Iron, lime, baryt, and a portion of ſilice are uſually found in union with native MANGANESE. Although this ſubſtance has been long known; yet it has not been long known as a metal. BERGMAN, SCHEELE, Gahn, Rinman, D'Engeſtroem, Ilſeman, De la Peyronſe, and FOURCROY are they who have the moſt carefully examined it.

4.
Character and relations of the oxyde.

OXYDE OF MANGANESE communicates a brown or violet colour to glaſs. But, this colour is eaſily alterable by combuſtible matters. It combines with ammoniac, and is reduced in this combination: For, the hydrogen of the ammoniac entering into union with the oxygen of the oxydated MANGANESE, affords a product of water, and another of gas-azote. There is alſo a well known combination of OXYDE OF MANGANESE with potaſh; in which a beautiful green colour is exhibited in hot water,—but, in cold water a red colour. It ſhould ſeem that theſe changes of colour may be owing to the varying oxydation of the MANGANESE. OXYDE OF MANGANESE diſſolved by ſulphureous acid, affords a tranſparent ſulfite of MANGANESE, the cryſtals of which are parallelopipeds. It is decompoſable by fire. The alkalis ſeparate from it an OXYDE OF MANGANESE, which by expoſure to the air, acquires a very beautiful colour. This OXYDE is ſubject to be diſſolved by the *nitrous* acid, or even by the *nitric* acid with the preſence of ſome combuſtible body. Theſe ſolutions yield under the reaction of the alkalis, a white precipate, ſoluble in acids. Water precipitates OXYDE OF MANGANESE from the muriatic ſolution of this metal. *Muriatic acid* diſtilled on OXYDE OF MANGANESE, detaches a part of the oxygen; and muriatic acid gas is conſequently evolved. There is ſaid to be in Derbyſhire, a black OXYDE OF MANGANESE in ore which is known by the name of *Black Wadd.*

5.
s uſes.

OXYDE OF MANGANESE is at preſent employed in the glaſs-houſes, both to purify white glaſs from yellow, green, or blue ſtains,—and to give it a violet colour. It is employed, too, in the preparation of oxygenated muriatic acid, and in many other preparations. Heated in a pneumato-chemical apparatus, it affords gas-oxygen in great abundance.

SECTION EIGHT.

OF ANTIMONY, AND ITS COMPOUNDS.

BOOK VII. SEC. VIII.

1. Origin and various ores of ANTIMONY.

ANTIMONY is a metallic ſubſtance which has been found in various forms, and is applied to many different uſes. It is uſually found in combination with ſulphur. Sometimes we meet with it in a ſulphuric ore of antimony cryſtallized in hexahædral priſms which terminate in tetrahædral pyramids obtuſe and ſolitary. It appears at times in ſtriæ, which conſiſt of large ill-ſhaped needles irregularly bundled together. It is alſo often in ſtellated ſtriæ in which the needles are divergent from a common centre. It is ſometimes ſparkling, and lamellated in plates of various ſizes. It is formed alſo in a red efloreſcence on the ſurface of the needled ore: Sometimes this red ore is cryſtallized in priſms or needles of which the colour varies in deepneſs and brightneſs. Native antimony in its pure metallic form, has been found in the mines of Allemont in Dauphine, in in large plates. A native OXYDE OF ANTIMONY has been diſcovered in fine white needles, or bundled together, like zeolite at Chalanges in Dauphine. Mines of ANTIMONY have for ſome time been wrought with ſome advantage on the eſtate of Sir William Pulteney Johnſtone of Weſterhall in Dumfries-ſhire, in Scotland. In Hungary, in France, and in various other countries, ANTIMONY likewiſe abounds.

2. Purification of theſe ores.

To purify the ores of ANTIMONY from the ſulphur with which they are uſually mixed in nature, it will commonly be ſufficient to roaſt the ores by a moderate heat in the open air. The ſulphur, in this operation, flies off, and leaves the

the ANTIMONY without mixture, and unaltered f
oxydation. The intenſity of the fire, may be aug
while the ſulphur flies off. But, it is extremely diffi
detach the leaſt remains of the ſulphur; as theſe
with extraordinary tenacity, to the metal. After t
ceſs, the ANTIMONY remains in a grey oxyde which
conſiderably contaminated with ſulphur. Urged wi
tinued intenſity of heat, this grey oxyde is reduced
glaſs of a reddiſh brown or an hyacinthine colour.
ed with an equal quantity of black flux and a ſm
portion of black ſoap or oil, the grey or vitreous
OF ANTIMONY is reduced into the perfect metallic ſt

3.
racters
re AN-
NY.

ANTIMONY in its pure and perfect metallic ſtate,
ſparkling white colour, in large plates, brittle, pon
apt to exhibit on its ſurface, a cryſtallization refe
ſtars or fern leaves. It appears likewiſe in trihædr
ramids, conſiſting of figures like hoppers which ſt
their angular points, one above another. In wate
ſame metal loſes $\frac{1}{7}$th part of its weight. It is eaſily
ble to a powder. It acts in a very ſenſible manner
ſtomach; and is both emetic and purgative.

4.
Its reactions
with other
chemical
ſubſtances.

ANTIMONY is liable to no alteration from the con
light. It does not melt till red-hot. Expoſed to an
heat in cloſe veſſels, it is wholly volatilized, without
ing decompoſition. Left to cool ſlowly after this fu
aſſumes that hoppered cryſtallization which was abov
tioned. By fuſion in open veſſels, it is quickly ox
in a white ſmoke; which is precipitated on the ſur
the melted metal, or fixed on the lid of the cruc
ſmall white needles; and which has been improper
nominated *ſnow of antimony*. From combuſtible m
ANTIMONY ſuffers alteration. By the *air*, its ſurface

little tarniſhed. It is not ſoluble in *water*. The
have no power of action on ANTIMONY. The *ſul-*
acid, if boiled over ANTIMONY, diſſolves and *oxydates*
ion of the metal. The ſolution is attended with the
ion of pure ſulphur, and of ſulfureous acid gas. The
e conſiſts of *ſulfate of antimony* and OXYDE OF ANTI-
both which have been formed in the proceſs. *Ni-*
id diſſolves a portion of that ANTIMONY on which it
red; producing, a *nitrate of antimony*, and *oxyde of an-*
. The oxydes of antimony obtained by the nitric
e ſulphuric acids, are exceedingly difficult of reduc-
Muriatic acid diſſolves ANTIMONY by long digeſtion
t. A muriate of antimony is obtained in ſmall deli-
nt needles by violent evaporation. It is known by
nproper denomination of *butter of antimony*. This
eits in the fire, and is decompoſable by diſtilled wa-
This ſalt may alſo be obtained by triturating 1 part
tive ſulphure of antimony with 2 parts of mercurial
te, and then expoſing this triturated maſs to diſtilla-
The muriate of antimony is then ſublimated; and
lphur combines with the mercury, to form cinnabar.
itro-muriatic acid diſſolves ANTIMONY with a more
energy than that of either of the two acids of which
ompound acid is formed. *Nitro-muriate of antimony* is
deliqueſcent, and may be decompoſed like the other
combinations of this metal. ANTIMONY, by various
ſes decompoſes ſulphate of potaſh, nitrate of potaſh,
te of ſoda. All combuſtible matters act more or leſs
s metal. Gas-hydrogen alters its ſurface and colour.
ur enters readily into an artificial union with this me-
hich forms a mixture ſimilar to the native ores of
ONY. Alkalin ſulphures alſo diſſolve the metal. The
combinations

BOOK VII. Sec. VIII. combinations of ANTIMONY with *arſenic* and *biſmuth*, hav not yet been examined.

5. The oxydes of ANTIMONY. OXYDE OF ANTIMONY is obtained from the ore or fro the purified metal by ſeveral proceſſes already mentioned. In all inſtances in which at a proper temperature, there a preſented to ANTIMONY, ſubſtances containing oxygen th has a ſtronger tendency to combine with the ANTIMONY than to remain in union with the ſubſtance in which it a firſt exiſts; the metal will invariably be oxydated. The GREY OXYDE OF ANTIMONY is, as we have ſeen, uſually obtained from the ſulphurated ore. The *vitreous oxyde* is produced in conſequence of urging the grey oxyde with a ſtrong intenſity of heat. The *white ſublimated oxyde of antimony* is produced by the ſublimation of metal under the action of heat in open veſſels. From the action of the nitric, the ſulphuric, the muriatic, and the nitro-muriatic acids, we have ſeen that there are OXYDES OF ANTIMONY produced with ſome diverſity of qualities. By the action of the different neutral ſalts upon this metal, we have ſeen, that it undergoes in moſt inſtances, more or leſs of oxydation. Such is the origin of the OXYDES OF ANTIMONY. The *white ſublimated oxyde* if urged with fire, is again ſublimated by itſelf. It may likewiſe be melted into an orange-coloured glaſs, paler, more tranſparent, more difficult to melt, than that which is formed with the *grey oxyde of antimony*. The *white ſublimated oxyde* appears to be ſoluble in water; and ſeems to communicate to that fluid, certain emetic qualities. *Oxydes of antimony* in general, but particularly thoſe formed by the action of the acids, are extremely difficult of reduction. ANTIMONY is oxydated the moſt eaſily by the oxydated muriatic acid.

SULPHURE OF ANTIMONY being much uſed in preparations for the purpoſes of medicine, deſerves to be here particularly examined and deſcribed. It is generally more entirely diſſolved, but leſs completely oxydated by acids, than the pure metal. The nitro-muriatic acid may be beneficially employed to ſeparate the ſulphur, which it precipitates in the form of a white powder. Roaſting is, as we have ſeen, employed for the ſame end of driving off the ſulphur. It is the ſame thing which is accompliſhed by the detonation of SULPHURE OF ANTIMONY with nitrate of potaſh. Iron and ſome other metallic ſubſtances likewiſe extract ſulphur from its union with ANTIMONY. One part of SULPHURE OF ANTIMONY, detonized with three parts of nitre, affords that white oxyde which is named *diaphoretic antimony*. Equal parts of the ſalt and the mineral, mixed together, and poured by ſpoonfulls into a red-hot crucible, detonize more ſlowly, and afford a brown *opake glaſs of antimony*, covered with ſcoriæ: for in this inſtance the ſulphur not being completely burnt, makes the *oxyde of antimony* to melt with itſelf into a glaſs. If not urged by fire into a state of fuſion, the product of this operation, is nothing but a vitreous ſcoria, which was formerly named *Rulland's falſe liver of antimony*. Reduced to powder, and then waſhed with water, this matter forms what is called *crocus metallorum*. There is another ſulphurated glaſs of ANTIMONY known by the name of *ruby of antimony*, or *magneſia opalina*, which may be obtained by melting in a crucible, equal parts of decrepitated muriate of ſoda, nitre, and SULPHURE OF ANTIMONY. It is a vitreous maſs of a light brown colour, very brilliant, and covered over with white ſcoriæ. Another ſulphurated glaſs of ANTIMONY, improperly termed *medicinal regulus* is prepared by melting a mixture of 15 ounces [illegible] SULPHURE OF ANTIMONY, 12 ounces of d [illegible] of soda, and 3 ounces of tartar. The [illegible] black glaſs, very opake, and very denſ [illegible] way, pure ANTIMONY may be extracted fr [illegible] ure by mixing together 6 ounces of tar [illegible] of nitre, and 8 ounces of SULPHURE OF ANTI throwing the mixture by ſpoonfulls into a red-hot cru [illegible] its fuſion; and then pouring the whole in [illegible] greaſed and heated: The pure antimony, the whole is cool, will be found in a pyramid at the b of the veſſel: If it be ſufficiently pure, its upper will exhibit the regular appearance of a ſtar. It w covered, too, with ſcoriæ; which, if boiled in a quantity of water, will yield by filtration a carbona matter. The remaining liquor, clear while it con warm, becomes turbid by cooling, and then depoſ reddiſh matter which is termed *kermes mineral* by th way,—but is at preſent believed to be *antimoniated ſu of potaſh*. An acid poured into this liquor, precip from it, a ſulphurated oxyde of antimony of an o yellow colour, which was formerly called *golden ſilver timony*, and which differs but little from *kermes*. SULP OF ANTIMONY reduced to a powder, and boiled for moments in water containing carbonate of potaſh or da; depoſites, after filtration, and by cooling, a porti *kermes* or *red ſulphurated oxyde of antimony*. An alk lixivium boiled anew over the reſidue, will cauſe it to another depoſite of *kermes*, ſomewhat paler in colour the firſt. A number of other metallic ſubſtances alſ [illegible] the ſulphur from the ANTIMONY. Tin, iron, co and ſilver, are all capable of effecting this decompoſ Only, a fuſing heat is neceſſary to the union. Amo

ate if diſtilled with SULPHURE OF ANTIMONY, af-
pulverulent, purple ſublimate, which appears to be
f antimoniated ſulphure with a baſe of ammoniac.

MONY is much employed in medicine and in the
t was once much uſed in pills, as a purgative me-
But, ſafer and leſs uncertain purgatives having
opted; the antimonial pills are now little uſed.
RE AND OXYDE OF ANTIMONY in their different
ions of—Crude ſulphure of antimony,—Rotrou's
—diaphoretic antimony,—kermes mineral,—golden
—are now the only antimonial medicines frequent-
ibed. Scrophulous diſorders, pituitous affections
omach, lungs, inteſtines, and urinary paſſages, and
which a ſudorific effect is required,—are the in-
n which theſe antimonial remedies are uſually gi-
NTIMONY is uſed in caſting types for printers; and
s of the arts.

6.
Uſes of antimony.

OK VII. ounces of ſulph [illegible]
r. VIII. tated muriate of f [illegible]
is a gliſtering bl [illegible]
the ſmall way, [illegible]
ſulphurated [illegible]
ounces of ni [illegible]
pouring th [illegible]
awaiting it [illegible]
iron con [illegible]
the wh [illegible]
of th [illegible]
will [illegible]
cov [illegible]
qua [illegible]
ma [illegible]

[illegible], the moſt comn
[illegible] times in the ſtate o
[illegible] form: And in thi
[illegible], greyiſh, and inflam
[illegible] oxyde, intermixed with
[illegible] many diverſities of for
[illegible] minated calamine or *lapi*
[illegible], it is mineralized by ſu
[illegible] *ſulphure of zinc*, or *blende*: I
[illegible] a diverſity of polygonal fi
[illegible] ſparry and carbonated, or form
[illegible] a ſulphate of zinc in rhom
[illegible] or in ſilky filaments. It is fou
[illegible] in Britain, in Norway, in Italy
[illegible] countries.

[illegible] oxydated ores of ZINC are aſſay
[illegible] a powder, mixing it with charcoal
[illegible] in a crucible covered with a pl
[illegible] The copper immediately becomes yellow
[illegible] braſs. And the ſame aſſay may be
[illegible] performed in the humid way, with ſulp
[illegible] these *calamines* are of a more compoun
[illegible] be treated three times ſucceſſively wit
[illegible] afterwards with muriatic acid. *Blendes*, o
[illegible] *of* ZINC may be beſt aſſayed by the
[illegible] acid, and by diſtillation. To obtain

for uſes in the large way, the ſulphurated ores are melted in mixture with lead: And the ZINC is then partly ſublimated, in part precipitated by cooling at the forepart of the furnace. That which is ſublimated, is particularly denominated by the improper appellation of *cadmia fornacum*. In Britain, ZINC is obtained in the great way by diſtillation in an oven-ſhaped furnace, in which are placed pots containing calamine and charcoal, and having each an iron pipe paſſing from it, through the floor of the furnace into a veſſel of water. The ZINC is ſublimated by the heat; and paſſing through the pipes into the water, is there condenſed and fixed into ſmall particles. Theſe are afterwards melted into ingots, which are expoſed to ſale by the name of *ſpelter*. This mode of extracting zinc from its ores, is ſaid to be of Chineſe origin. Our pureſt ZINC is obtained from China, under the appellation of *tutenag*. It is a very rich ore, and contains from ,60 to ,90 parts of pure zinc.

3.
The characters of the pure metal.

Pure metallic ZINC is cryſtallized in narrow laminæ or in larger plates; is brittle, yet yields with a certain degree of elaſticity under the hammer; is of a blueiſh white ſparkling colour; is eaſily fuſible; is of all metals the moſt inflammable; when red-hot, burns with a beautiful yellowiſh white flame; decompoſes water with great energy.

4.
Its reactions with other chemical ſubſtances.

If expoſed to heat in cloſe veſſels, ZINC melts, and volatilizes without being decompoſed. If ſuffered to cool ſlowly in a veſſel from which a part of it may run out; the remainder is cryſtallized in needled priſms. Expoſed to the *air*, while in fuſion, it is covered with a grey pellicle which is ſoon converted into a yellowiſh oxyde, eaſily reducible. In other reſpects, this metal is ſcarcely alterable by the influence of air. Meſſrs LAVOISIER and DE MEUnier in their experiments on the decompoſition of *water,* found that ZINC when juſt beginning to be red-hot detached the oxygen of that fluid with great force. ZINC is capable of entering into vitreous compounds, and of communicating to glaſs, a yellow colour. Liquor of cauſtic *potaſh,* or *ſoda,* if boiled over ZINC, blackens the ſurface of the metal, and oxydates a part of it. *Ammoniac,* on account of its volatility, acts with leſs energy on this metal. Sulphuric acid, cold, poſſeſſes the power of diſſolving ZINC; the acid being diluted in water. The *ſulphate of zinc,* which is the product of this decompoſition, is cryſtallizable in tetrahedral priſms, terminating in pyramids that have alſo four ſides. Its taſte is ſtiptic; and it ſeems to be convertible into *ſulphite of zinc* by the action of heat. *Sulphate of zinc* is inalterable by air; is decompoſable by alumin, baryt, magneſia, lime, and the three alkalis; mutually decompoſes, and is decompoſed by nitre. It is improperly termed in commerce *white copperas* or *vitriol of goſlard.* *Nitric* acid if diluted in water, and cold, combines with ZINC with great force and rapidity. There is an emiſſion of heat while the combination takes place, and a large diſengagement of nitrous gas. The *nitrate of zinc* now formed, affords by evaporation and cooling, compreſſed and ſtriated tetrahædral, terminating in four-ſided, ſtriated pyramids. It is reducible to *nitrate of zinc* by diſtillation, which evolves from it a quantity of nitrous gas. It deliqueſces when expoſed in the open atmoſphere. The muriatic acid acts on zinc with as much energy as the nitric acid. The ſolution thus effected, is colourleſs, and does not cryſtallize by evaporation. By diſtillation it affords a ſmall portion of highly fuming muriatic acid, with a ſolid fuſible *muriate of zinc.* The *carbonic acid* diluted in water, and digeſted over zinc, diſſolves a

no

ot inconſiderable portion of it in the ſpace of twenty-four ours. The ſolution being expoſed to the air, affords a ariegated pellicle of *carbonate of zinc.* All ſolutions of inc in acids are precipitated by lime-water, magneſia, fixd alkali, and ammoniac. ZINC decompoſes ſulphate of potaſh by attracting its oxygen: when in filings, makes itre detonize with aſtoniſhing rapidity; decompoſes alſo uriate of ſoda; effects the ſame decompoſition with a more powerful energy upon ammoniacal muriate; forms a *ſulphate of zinc* by the decompoſition of *ſulphate of alumin.* Immerſed in gas-hydrogen, ZINC has been obſerved to aſſume, after ſome time, a very bright but changeable blue colour. It is almoſt incapable of combination with ſulphur. Yet, by fuſion, an artificial *blende* may be formed, in which the ſulphur is combined either with ZINC or with its oxyde. This metal is not incapable of union with *arſenic*; but, with the oxyde of arſenic unites leſs eaſily. With antimony, it forms a hard brittle mixture.

5. Oxyde of zinc.

We have ſeen, that in the native ores of ZINC, it is generally an oxyde that is found, not the perfect metal. In he moſt part of its artificial combinations, the metal is oxydated by the combining proceſs; and by conſequence xiſts only in its oxyde, in the new compound. The OXYDE OF ZINC obtained by the expoſure of melted ZINC to he atmoſphere, is yellowiſh. But if this ſame melted meal be expoſed to a greater intenſity of heat, the OXYDE is olatilized by the current of the flame, aſcends, and is aferwards condenſed into little white flakes, which are improperly termed *flowers of zinc, pompholix, nihil album, philoſophical wool or cotton.* Their gravity is greater than that of the metal from which they are formed; being augmented by the weight of the oxygen which they have acquired.

This

This oxyde if expoſed again to heat, remains fixed
plays a phoſphoric light in the dark, and melts into a
tiful yellow coloured glaſs. Oxyde of zinc expoſ
heat in contact with carbon, yields a part of its oxyg
the carbon, and is thus itſelf reduced in part to a m
Oxyde of zinc is alſo obtained by precipitating the aci
lutions of the metal with lime, magneſia, potaſh, ſod
ammoniac. It appears in flakes and is eaſily reducibl

6. Its uſes.

In the arts, zinc enters into ſeveral metallic mixtu
particularly into tombac and prince's metal. Filing
zinc are mixed with powder, to produce artificial ſta
fire works. Zinc has been recommended as preferab
tin for the purpoſe of plating copper veſſels. Sublim
oxyde of zinc has been given ſometimes ſucceſsfully, ſo
times ineffectually as an antiſpaſmodic. *Pompholix*, tu
&c. are uſed as excellent deſiccatives for humours aff
the eyes.

SECTION TENTH.

OF MERCURY, AND ITS COMPOUNDS.

BOOK VII. SECT. X.

I. Origin of MERCURY

MERCURY is not a metallic ſubſtance extremely plentiful in nature. It is found in a virgin ſtate, poſſeſſing all its metallic properties; in a ſtate of oxydation; or in combination with acids, ſulphur, and other metallic matters. Virgin or fluid mercury has been found in globules or in large maſſes, in earths and ſoft ſtones, and moſt frequently in the cavities and interſtices of its own ores. At Ydria, in Spain, and in America, it is gathered in the cavities and clefts of the rocks. It is found in clay at Almaden, in beds of chalk in Sicily. It is to be found alſo at times among ſilver and lead ores, as well as mixed with white oxyde of arſenic. At Ydria in Friuli, has been found a red-brown ore of mercury, ſoft and granulated in its fracture, which is regarded as a carbonated oxyde of mercury, and which has been found to afford 91 parts of mercury, out of 100 parts of the ore. A cryſtallized ore of MERCURY, which a proper aſſay ſhewed to be a compound of ſulphate of mercury with corroſive mercurial muriate, was in the year 1776 found by *Mr Woulfe* at Obermuſchel in the Duchy of Deux-Ponts. In nature, mercury is ofteneſt found in combination with ſulphur. This natural compound is generally known by the name of cinnabar. It is found in the Duchy of Deux-Ponts, in the Palatinate, in Hungary, in Friuli, at Almaden, and in South America—where it chiefly abounds at Guamanga in Peru. There is a blackiſh ore of MERCURY in which it is ſaid to be combined with ſulphur and copper, and which is found at Muſchel-Landſberg.

ſberg. Mercury has been found, too, in amalgamation with virgin ſilver, in the ore of Sahlberg in Sweden. There is alſo ſaid to have been obtained from Dauphine, an ore of mercury, containing mercury, ſulphur, arſenic, cobalt, iron, and ſilver; and which afforded, upon aſſay, 1 pound and 3 or 4 ounces of mercury out of the hundred weight of ore.

2. Aſſay of its ores, and extraction of the metal.

An ore of mercury may be aſſayed by pounding a portion of it, mixing it with lime, alkalis, &c. placing it on a hot brick, and holding over it a bell-glaſs to receive the ſublimated mercury, which will be condenſed on the ſides of the glaſs. Virgin mercury is obtained pure by grinding down the ſtones that contain it, and diluting the powder in water: the mercury is then precipitated. *Cinnabar* is almoſt always found in nature, in mixture with ſome calcareous or martial ſubſtance, which contributes as an intermedium to its decompoſition by fire. In Spain, at Almaden, the mercury is extracted from *cinnabar* in the great way, by heating the *cinnabar* with combuſtible matters in a ſort of reverberating furnace, with a few holes in its back, and aludels beyond, correſponding to theſe holes: the ſulphur is abſorbed by the iron and calcareous matters of the native combination, while the mercury, being ſublimated by the heat, paſſes through the holes in the back of the furnace, and is condenſed in the aludels. However this proceſs may be in other inſtances diverſified; lime and carbonaceous matter are ſtill employed to kindle up a due intenſity of heat, and to abſorb the ſulphur; and the pure mercury is ſtill procured by ſublimation.

3. Characters of the pure met

Pure fluid mercury, however obtained, is fuſible at the temperature of 35° under zero in Fahrenheit's thermometer, and at 38° under zero congeals. It is reducible by

comminuti

ation and diviſion to a black oxyde. It has the nd brilliancy common to metals. It is, next after d platina, the moſt ponderous ſubſtance known. foot of MERCURY, if very pure, weighs 947 pounds. it loſes $\frac{1}{13}$th part of its weight. Its ductility or cannot be determined. Its exceſſive weight, fluidity, extreme volatility, and the ſingular alte- t is liable to ſuffer by combination, may induce us d it as a peculiar ſubſtance, not otherwiſe allied to als, than by its brilliancy, gravity, and combuſtibi-

4. Its reactions with other chemical ſubſtances.

URY does not appear to ſuffer any alteration from t is one of thoſe fluid matters which are the moſt d uniformly heated. Of all fluids, it has been y experience the fitteſt for the conſtruction of ac- hermometers. It was firſt proved to be ſuſceptible elation, ſince the middle of the preſent century, xperiments made at Peterſburgh, at Hudſon's bay, rdam, and in England. If expoſed to fire in cloſe it boils like other fluids. The vapour into which nsformed by ebullition, appears in the form of a noke, obſcures the tranſparency of the veſſels into t is received, and is condenſed by cold into drops d *mercury*. It may be purified, like water, by diſtil- *Boerhaave* diſtilled the ſame quantity of MERCURY, nes ſucceſſively, without effecting any alteration . Its *taſte* is indeed imperceptible to the organs of et produces a ſenſible effect on the ſtomach, the in- , and the ſurface of the ſkin. Inſects and worms ly deſtroyed by it. The vapours of MERCURY have rful expanſive force, ſufficient to burſt even an iron nd to produce various conſiderable exploſions.

MERCURY is extremely ſuſceptible of oxydation by the contact of air, and other bodies: a blackiſh grey pellicle is continually forming on its ſurface, which is nothing elſe than an oxyde. If heated with acceſs of air, this metal is within a few days, changed into a red, brilliant, ſcaly, earthy powder, which is likewiſe an oxyde. A very large and broad cryſtal bottle called *Boyle's hell*, has been contrived for the purpoſe of oxydating mercury without the contact of any ſecond ſubſtance to favour the oxydation. A quantity of mercury is incloſed in this bottle, in ſuch a proportion as to be ſpread in a very thin layer over its ſurface. The mouth of the bottle is fitted with a cryſtal, cylindrical ſtopper, perforated with a capillary tube. The bottle is then placed on a ſand-bath, and the mercury is thus heated to ebullition. The capillary aperture in the ſtopper of the tube admits the external air, without ſuffering the MERCURY to eſcape. Digeſtion in this manner for the ſpace of ſome months, affords in the end a large proportion of MERCURIAL OXYDE. The ſame thing may be accompliſhed within a few days, fifteen or twenty, by uſing broad-bottomed mattraſſes. MERCURY is very little, if at all liable to ſolution in water. It is not more diſpoſed than are the other metallic ſubſtances, to unite with *earths*. Concentrated *ſulphuric acid* is capable of diſſolving MERCURY, with the aid of heat. There is a diſengagement of ſulphureous acid gas, and the liquid acid remaining, becomes turbid with MERCURIAL OXYDE. The ſulphuric mercurial maſs thus obtained, is ſoluble and precipitable in hot water into a beautiful yellow powder, known by the name of *turbith mineral* or *yellow precipitate*. MERCURY decompoſes the nitric acid with great rapidity. A *mercurial oxyde* is produced by this decompoſition. And nitrous-a-

cid-

is at the ſame time diſengaged. The *muriatic* acid
ot act in any ſenſible degree upon pure metallic
RY. The *boracic acid* is not capable of diſſolving
RY without an intermedium. We know not well,
t manner, the *fluoric* and the *carbonic* acids act upon
tal. The neutral ſalts are underſtood to poſſeſs no
powers of acting upon MERCURY. This metal has,
er, been remarked to incorporate readily with ſul-
of potaſh. MERCURY triturated with *muriate of am-*
affords, with the aid of moiſture, lengthened ex-
to the air, and at laſt ebullition in alcohol, and up-
nd-bath,—an ammoniaco-mercurial-muriate, a new
culiar neutral ſalt. We know not how *gas-hydrogen*
on MERCURY. With *ſulphur*, this metal readily com-
A black *ſulphure of mercury*, improperly named *E-*
ineral, is the reſult of the combination. Another
tion of MERCURY with ſulphur, forms what is called
ion. Native *cinnabar* is a mixture of a ſimilar cha-
Alkaline ſulphures are ſubject to be inſtantaneouſly
poſed by MERCURY. Running MERCURY, if ſhaken
r impregnated with *ſulphurated hydrogenous gas*, oc-
a decompoſition of which the reſult is a black *ſul-*
f mercury. Biſmuth readily unites with MERCURY, in-
ight friable matter, more or leſs ſolid, according to
antity of the *biſmuth*. This amalgam cryſtallizes in-
-ſided figures which ſometimes join in octohædrons:
frequently, however, this cryſtallization is into thin
of no regular form. By fuſion, MERCURY may be
t to unite with *zinc*; but by no means with nickel
mony. The amalgam of MERCURY with zinc, is ſo-
t may be rendered fluid by trituration. It cryſtallizes
plates, apparently rounded at the edges.

5. Nature and relations of the OXYDE of mercury.

The OXYDE OF MERCURY is obtained by a number of the proceſſes with acids, &c. which have been above enumerated. It is obtained more particularly by that proceſs which was deſcribed as oxydating this metal without the preſence of any ſecond ſubſtance, ſave atmoſpheric air. Of this proceſs, and the oxyde formed by it, we may obſerve; that only the oxygenous part of atmoſpheric air, contributes in this inſtance, to the oxydation of the metal; that the weight of the MERCURY is always augmented by its oxydation; that, this *oxyde or precipitate per ſe*, is reducible by expoſure to heat in cloſe veſſels, and gives out, while it is reduced, a large quantity of genuine gas-oxygen; that however, when heated with *acceſs of air*, and only then, this OXYDE OF MERCURY is not reduced, but is entirely ſublimated, and may, even be melted into a glaſs of a beautiful red colour; that, after all, this ſublimated and vitrefied oxyde is, at laſt reducible by the action of a ſufficiently intenſe heat, applied to it in cloſe veſſels. This RED OXYDE OF MERCURY might, no doubt, be fixed in glaſſes, like the oxyde of arſenic. The oxyde produced by the ſolution of MERCURY in concentrated ſulphuric acid, is by cold water obtained in *a white precipitate*,—by hot water,—in *a yellow precipitate*. It is reducible by expoſure in a retort to the continued action of fire: A plentiful diſengagement of gas-oxygen accompanies its reduction. Of the OXYDE OF MERCURY produced by its ſolution with the concentrated ſulphuric acid, a part entering into a perfect ſaline combination with the acid, forms with it a genuine *ſulphate of mercury*. This ſalt, by evaporation with a ſtrong heat, is obtained in ſmall needles, of indeterminate form, ſoft, and deliqueſcent. When the ſulphuric ſolution of MERCURY is not overcharged, but merely ſaturated with metallic oxyde, no precipi-

tate,

ate, white or yellow is to be obtained from it. Sulfate of ERCURY is decompoſable by lime and magneſia, as well as y the fixed alkalis. With *ſulfate of mercury* with exceſs of cid, *ammoniac* forms a triple ſalt, *ammoniaco-mercurial-ſulſate.* That *oxyde of mercury* which exiſts in *mercurial nitrate,* is ſeparable in part by diſtilled water, when the acid is ſuperſaturated with the oxyde; but if the acid be only duely ſaturated, or even not ſufficiently ſaturated with oxyde; no precipitation of oxyde or decompoſition of the neutral ſalt, an be accompliſhed by diſtilled water. The ſolution of ERCURY in *nitric acid,* is exceedingly cauſtic and corroſive, apable even of deſtroying the organs of animals. It is tained, as circumſtances vary, either—in flat ſolid cryſtals of 14 ſides formed by the junction of 2 tetrahædral pyraids, cut very near the baſe, and truncated at the 4 angles hich reſult from the junction of the pyramids;—in acute riated priſms;—in long and very acute flat needles, ſtriated ngth-wiſe;—or in very long needles, ſlender, flexile, and oſſy like ſattin. In whatever form of cryſtallization, *nitte of mercury* is ſtill cauſtic and corroſive,—ſtill detonizes burning coal,—melts by heat in a crucible,—yields a *red ecipitate* or oxyde by fuſion,—affords by diſtillation nits-gas, gas-azote, and reduced mercury,—becomes yellow-, and is ſlowly decompoſed in the air,—is ſoluble in war, whether cold or boiling,—and cryſtallizes by cooling. riatic acid, although incapable of combination with the tal, readily combines with its oxyde, with attractions re powerful, than thoſe ſubſiſting between this oxyde d any of the other acids. The combination of OXYDE MERCURY with muriatic acid, is ſuſceptible of two different ſtates: In one, formed with the common muriatic l, it is *mild mercurial muriate:* In the other, formed with the

the oxygenated muriatic acid, it is *corroſive ſublimate* or *corroſive mercurial muriate.* The moſt common mode of preparing *corroſive mercurial muriate*, is the following. Mix equal parts of dried nitrate of mercury, decrepitated muriate of ſoda, and white ſulfate of iron. Put this into a mattraſs of ſuch a capacity, that it may be only one-third filled by the mixture. Immerſe it into a ſand-bath, and heat it gradually till its bottom be red-hot. The ſulfuric will diſengage the muriatic acid: the ſoda will detach the nitrous acid: The oxyde of mercury, and the muriatic acid being thus reſpectively ſet at liberty, will combine: The reſult will be—*corroſive mercurial muriate;* For the oxygen in the mercurial oxyde added to that in the common muriatic acid, occaſions the effect to be the ſame as if oxygenated muriatic acid had been at the firſt employed. Kunckel, and after him, Boulduc, have given a very good proceſs for preparing *corroſive mercurial muriate* in a ſtate of extraordinary purity. Heat together in a mattraſs, equal parts of ſulfate of mercury and decrepitated muriate of ſoda. You will obtain a ſublimate of corroſive muriate of mercury; and only ſulphate of ſoda will remain in the bottom of the mattraſs. However we may judge of theſe two proceſſes; there is yet a third; which conſiſts ſimply in the pouring of oxygenated muriatic acid into a ſolution of nitrate of mercury, and then ſlowly evaporating the mixture. Cryſtals of *corroſive mercurial muriate* are thus obtained. *Corroſive mercurial muriate* acts with great energy on the animal ſyſtem. Its taſte is ſtrongly ſtiptic and metallic. A few grains of it, taken in an equal portion of water, are ſufficient to operate as a ſtrong poiſon. It ſuffers no alteration from *light*. It is volatilized and imperfectly vitrified by *heat*; which, if intenſe, and acting in the open air, diſſi-

in a white ſmoke. Heat acting on it, more ſlowly,
tes it in a regular cryſtalline form. Its cryſtals are
mpreſſed priſms, terminating in very acute points.
r this ſalt ſuffers no alteration ; nor is it decompoſ-
re. It is ſoluble in 13 parts of water to 1 part of
; and is again cryſtallizable from this ſolution, into
ins, which are obtained by evaporation. It is de-
ible by baryt, magneſia, and lime, which make it
precipitate of OXYDE OF MERCURY. $\frac{1}{2}$ a drachm of
e mercurial muriate caſt into a quantity of lime-wa-
ords the *phagedenic water* employed by ſurgeons.
kali ſeparates from corroſive mercurial muriate, an
coloured oxyde. *Ammoniac* produces from it, a
recipitate which turns afterwards ſlate-coloured.
the acids, nor the alkaline neutral ſalts, produce
ration upon this ſalt. It contracts, but without
decompoſition, an intimate union with ammonia-
iate. The *ſal alembroth* of the alchemiſts, was form-
e union of theſe two ſalts in the way of either ſu-
n or cryſtallization. *Corroſive mercurial muriate* is
ect to be altered by gas-hydrogen. *Sulphur* pro-
o change on it ; but it is ſubject to be decompoſed
ine ſulphures. Its decompoſition by *arſenic*, affords
e of arſenic improperly named *corroſive oil*, or *butter*
. The effects of nickel, cobalt, and manganeſe on
e mercurial muriate have not yet been examined.
lation with *biſmuth*, it affords alſo a *muriate of biſ-*
properly called *butter of biſmuth*. By diſtillation
imony, it yields *muriate of antimony*, improperly term-
of antimony. Corroſive mercurial muriate is alſo
oſable by *zinc*. The new products are *muriate of*
mercury. With running MERCURY, *corroſive mer-*
curial

OOK VII.
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curial muriate is even capable of entering into combinati
and by this combination loſes its peculiar taſte and fol
lity, with moſt of its other ſaline properties. This
combination may be effected in the way of trituratio
which will be more eaſily and ſafely effected, if the *corroſ*
mercurial ſublimate be firſt formed into a paſte with wa
and then triturated with the running MERCURY. The
duct is known by the names of *mercurius dulcis*, or
properly *mild mercurial muriate*. This *mild mercurial*
contains the muriatic acid without any exceſs of
It is incapable of receiving into combination with
new quantity of running MERCURY. It may be
into the ſtate of *corroſive mercurial muriate* by ſubli
with decrepitated marine ſalt, and white calcined ſul
iron. So much for the OXYDE OF MERCURY and its
pounds.

6.
ſes of mer-
ury.

The fluidity of metallic MERCURY, and its ſingular
bility to heat and cold, are well known to fit it in a pec
manner for the conſtruction of thoſe valuable inſtru
of ſcience, the *barometer* and *thermometer*. Crude mercu
is boiled in water, as a vermifuge; and is mixed with fat
to be applied as an ointment in venereal complaints. *Yello*
oxyde of mercury, oxydated by the ſulphuric acid, is pow
fully emetic and purgative, when taken in dozes of a fe
grains. The nitric ſolution of MERCURY is a powerful
charotic; as is alſo *red precipitate*, which forms with fats,
ointment for the itch. Corroſive mercurial muriate ad
miniſtered in very ſmall dozes, is a remedy to be taken in
wardly for the venereal diſeaſe. *Mercurial borate* has bee
employed for the ſame uſe. Cutaneous diſorders, a ſcro
phulous habit, ſwellings of the lymphatics, &c. are all of
uſefully treated with mercurial remedies.

SEC

SECTION ELEVENTH.

OF TIN, AND ITS COMPOUNDS.

1. Origin of TIN.

TIN is found chiefly in the counties of Cornwall and Devonſhire in England; in the regions of Bohemia and Saxony in Germany; in the iſland of Banca and the peninſula of Malacca in the Eaſt Indies. It exiſts in nature, but in a few different ſtates. Pure native tin is found in leaves or plates. There is a white, ſparry ore of TIN in octohædral cryſtals. TIN ore is in ſome inſtances of a yellowiſh white colour, often coloured and ſemi-tranſparent, like topazes. There is a brown reddiſh TIN ore in cubic cryſtals, more or leſs regular. This metal exiſts alſo in a ſort of TIN-STONE or rather ſand; which is grey, blue, brown, or black, and contains a mixture of oxyde of TIN. Sulphureous tin ore, is another variety, which bears a reſemblance to zinc, or is gilded over, like *aurum muſſivum*.

2. Extraction of the metal from its ores.

In the aſſay of ore of TIN, the uſual mode of pounding and roaſting may be ſucceſsfully followed. The ore is broken into lumps, coarſely pounded, waſhed, quickly roaſted in a covered earthen capſule; and then haſtily melted in a crucible with 3 parts of black flux, and a little decrepitated marine ſalt to 1 part of the roaſted ore. A compariſon of the reſpective weights of the waſhed ore, the roaſted ore, and the metallic button obtained by the fuſion, will enable us to infer, by what proportion of extraneous matters, the tin is here contaminated; and what proportion of pure tin, the ore will yield out of the cwt. TIN ores may alſo be aſſayed by the more expeditious method

thod, propoſed by Cramer. Take two pieces of charcoal made from the wood of linden or hazel: In one of theſe form a cavity to receive the TIN ore: Pierce the other with a hole which may ſuffer the vapours to eſcape, while it is uſed as a lid: Put in the ore: Lute the two pieces of charcoal together, and even bind them with iron-wire: Urge the ore thus contained with a ſufficient ſtrength of fire, before the nozzle of a forge: You will thus obtain the pure tin in a metallic button. Or, to aſſay tin ores, we may follow Bergman's method; diſſolve them in ſulphuric acid; pour into the ſolution a proportion of muriatic acid; and precipitate the mixture with fixed alkali. In the great way, mines and ores of TIN are uſually wrought by proceſſes nearly ſimilar to theſe. Fires are often kindled to calcine and ſoften the ore in the gangue. The ores are pounded, waſhed, roaſted in reverberating furnaces, melted at laſt in other furnaces, and poured into moulds which give it the form of blocks. The Indian tin is accounted more pure than that of England. Foreigners, eſpecially the Dutch, are ſaid to be in the practice of re-melting the blocks of Engliſh tin, and mixing them with alloy, in order to increaſe their profits upon the commerce; forging the Engliſh ſtamps, to give this counterfeit Engliſh tin, the ſame currency as if it were not alloyed.

3.
haracters
f the pure
netal.

Pure TIN is a gliſtering, white ſubſtance, ſoft, light, ſcarcely ſonorous, ſuſceptible of being ſcratched by the nail, very fuſible, very combuſtible. It is exceedingly pliant, and when bent, produces a crackling noiſe called the *cry of tin.* It yields by combination with oxygen, a white oxyde, which impairs the tranſparency of glaſs, and converts it into an enamel. In water, TIN loſes about $\frac{1}{7}$th of its weight. It has a ſenſible ſmell, which becomes ſomewhat ſtronger

when

when the metal is rubbed. Its taſte is peculiar and diſagreeable. It holds the ſecond place among the metals when they are arranged in the order of their ductility. Under the hammer, it is reducible into plates thinner than leaves of paper. It is ſo tenacious, that a thread or wire of tin, $\frac{1}{10}$th of an inch in diameter, will, without breaking, ſuſtain a weight of 49½ lib. It has been cryſtallized in rhomboidal needles bundled together, and joined longitudinally, by often repeated fuſion.

4.
Its reaction with other chemical ſubſtances.

TIN very quickly melts, when it is expoſed in cloſe veſſels to the action of fire. It is of all metals, the moſt fuſible. Greater intenſity of heat at length volatilizes it. When the metal is heated in contact with air, a pellicle of a dirty grey oxyde is formed on its ſurface. From air without heat, it ſuffers, if very pure, but little alteration. It is not abſolutely ſoluble in *water*; yet if long expoſed to the action of this fluid, is apt to become at length tarniſhed upon its ſurface. With earthy matters, it never contracts any union. *Alkaline* ſolutions make TIN to aſſume, in a ſhort time, all the colours of the rainbow. Concentrated ſulphuric acid is ſaid to diſſolve, with the help of heat, half its own weight of TIN. Sulphureous acid gas is diſengaged during the proceſs; and the TIN is oxydated. The ſame thing takes place; but more faintly and ſlowly, and with greater permanency of the ſolution; when diluted ſulphuric acid is employed. Even cold, the *nitric acid* decompoſes TIN with great rapidity; the metal is oxydated; and by the decompoſition of both the acid and the water of the ſolution, there is a portion of gas-ammoniac formed. The *fuming muriatic acid*, with either heat or cold, diſſolves tin, and a concomitant decompoſition of the water of the ſolution, is at the ſame time effected. The *oxygenated muriatic acid*,

acid, too, very readily diſſolves tin without efferveſ
The nitro-muriatic acid combines with TIN with an
veſcence attending the act of combination: There is
ſiderable heat alſo given out upon this occaſion: If
manent ſolution be wanted; the metal muſt be imm
gradually, not all at once into the acid: This mixed
capable of diſſolving, and holding in ſolution, half it
weight of TIN. We know not in what manner the
acids act upon this metal. All ſulphuric neutral ſalts
eſpecially ſulphate of potaſh or of ſoda, are liable to
compoſed by tin. *Nitre* detonizes rapidly with this
if the metal be melted and heated in a crucible, till
ſume a dark-red colour; and the nitre in a powde
then thrown upon it. A white ſparkling flame acco
nies the detonation. The TIN is oxydated. TIN
decompoſes *muriate of ammoniac:* There is a diſengage
of gas-ammoniac occaſioned by this decompoſition.
may be eaſily combined with ſulphur, by caſting 1
parts of this combuſtible matter in powder upon 5
parts of TIN melted in an iron ladle. The mixture, i
red with a ſpatula, becomes black and is inflamed
melted in a crucible, it forms a brittle maſs in flat, bu
needles. This compoſition is more difficult to melt,
TIN. *Arſenic* can ſcarcely, on account of its volatility
united with TIN by fuſion. *Arſeniate of potaſh* is more
ly combinable with this metal. A brittle and very bri
button of mixed TIN and arſenic, is the reſult of this u
No violence of fire can ſeparate the TIN and arſenic
have once been thus united. *Cobalt* unites by fuſion
TIN; and the mixture is a fine-grained metallic ſubſ
of a light violet colour. TIN and *biſmuth* are ſaid to
together a brittle mixture with cubic facets; harder

w

hiter than pure TIN. The *vegetable acids* diſſolve TIN; ough not with an energy equal to that with which the ineral acids act upon it. The *tin of commerce* is a mixre of pure TIN with other metals. Engliſh TIN conins both copper and arſenic; and that which is ſold as gliſh TIN in Germany, contains alſo $1\frac{3}{80}$ parts of lead. he TIN uſed in the arts in France, is alloyed with copr, biſmuth, antimony, zinc, and lead. Fears have been caſionally entertained, leſt arſenic might exiſt in the in which is uſed for kitchen and table utenſils, in ſuch proportion as to injure the health of perſons taking food narily out of them. But, the accurate experiments of ne ingenious chymiſts, have evinced, that Engliſh TIN ver contains more than $\frac{1}{4}$ of a grain of arſenic in the nce of metal; and that a plate of ſuch metal does not e more than the $\frac{1}{5760}$th of a grain of arſenic in the —a proportion that can never become dangerous. d, however, is often added to TIN in the compoſition pewter, in a quantity that may have bad effects.

Tin of Commerce.

olution of any mixture of TIN with arſenic, in muriaacid, precipitates the arſenic in a black powder. ſame acid precipitates copper from any mixture of with copper—in a grey powder. The preſence of alloy of biſmuth, in a ſpecimen of TIN, is detected e ſame manner. Nitric acid detects lead in TIN, by lving the former, while it only corrodes the latter of metals.

6. Moſaic gold, &c.

rum *Muſivum*, or *Moſaic Gold*, is a beautiful amalof TIN with ſulphur, well known in the arts. To it—Equal parts of TIN and mercury are, firſt, amalmated, by pouring the TIN, melted, upon the mercury, heated retort, and then agitating and triturating the mixture till it is cold: Six ounces of ſulphur, a ounces of ſal-ammoniac, are then added to the The whole is put into a mattraſs, and this ma heated on a ſand-bath, to ignition in its bottor fire muſt then be maintained for three hours, in intenſity: At the end of this time, a very beautifu *Muſivum* is found to have been formed. T likewiſe other proceſſes for forming the ſame tion. Two parts of mercury, with one part of one of TIN; mixed together, after the fuſion of and the TIN; then agitated in a wooden box, the inſide has been rubbed with chalk; affords powder of which is wonderfully powerful, the energies of the electrical machine. Seven biſmuth, five parts of lead, and three of TIN, gether, a mixture ſubject to liquefaction in boiling

7. Uſes of Tin in the Arts. The amalgam of TIN with mercury is uſed looking-glaſſes. TIN is given in powders as a The oxydes of TIN in different combinations, uſe in the dyeing of ſome beautiful colours. Bra bell metal, is an alloy of TIN with copper. The TIN of conſiderable purity, covering plates of has, of late, almoſt ſuperſeded in Britain, that of ter and copper, for the manufacture of domeſtic

SECTION TWELFTH.

OF LEAD, AND ITS COMPOUNDS.

BOOK VII
Sect. XII.

1.
Ores of
Lead.

D, a metal applicable to many different uſes, is d in great abundance among the ſtrata of the earth, pears in a conſiderable variety of native forms.— imen of metallic LEAD, pure from all extraneous ation or mixture, is ſaid to have been found in outhſhire. At Villach, in Carinthia, too, and in Varais, in France, ſpecimens of ſimilar purity, are have been found. Wallerius ſpeaks, alſo, of three of what he conſidered as true native metallic LEAD. often found in nature, mineralized by oxygen, or rbonic acid. The white-lead ores of the LEAD r in Scotland, of the mines of Tipperary in Ireland, different parts of England and of France, are of rt. There are alſo a blueiſh, yellowiſh, or green- d a red LEAD ore, both mineralized in the ſame r. There is a phoſphorated LEAD ore of an green colour, and ſubject to many varieties of form. is mineralized by the arſenical acid, in the ſmall of ore of a meadow-green colour, which have been in Spain. The arſenical and the phoſphoric acids een diſcovered to mineralize this metal jointly, in a iſh green ore, which ſometimes inveſts ſmall fragments of quartz, in a maſſive form. Cryſtals of LEAD, lized by the ſulphuric acid, have been found by irwan, in a reddiſh brown maſs of ore, from a. There is ſaid to be a native muriate of LEAD,

of

of which ſpecimens have been found at Mies and Bley ſtadt, in Bohemia. Yet, it is uncertain, whether may not have been rather a phoſphorated LEAD. Lea is mineralized by the molybdic acid, in a pale yellow from Carinthia. In France, and in Siberia, have found ſpecimens of a red, ſparry, LEAD ore, owing mineralization to oxygen and molybdic acid. But, ores are much more frequently mineralized by than by any other ſubſtance. Theſe ores have the mon denomination of Galenas. They are of forms and colours; foliated, compact, cryſtallized, lactical; grey, blue, black, and brown. Iron and often contaminate certain LEAD ores. Of almoſt particular ſpecies of ore here enumerated, there are varieties. Silver uſually exiſts in a certain proportion, the common ores of LEAD.

2.
Aſſay of
Lead Ores.

LEAD ores, after being taken out of the mine, be aſſayed and purified. In the *aſſay*; pound the and waſh it; roaſt it in a covered veſſel; melt it three times its own weight of black flux, and a portion of decripetated ſea-ſalt. The fuſion will afford pure metallic button, by the compariſon of the weight which, with that of the ore employed in the aſſay, you diſcover the particular richneſs or poorneſs of your ore general. Or, the *aſſay* of ſulphurated LEAD ores may be made, as Bergman has propoſed, by nitric acid. Th acid diſſolves the LEAD, leaving the ſulphur ſeparate The ſolution is then to be precipitated by carbonate Soda, which detaches the nitric acid: If the precipitate ſuſpected to contain ſilver, ammoniac digeſted over will diſſolve the oxyde of ſilver, and leave the LEAD without mixture.

The

3.
Purification of theſe ores in the great way.

The following are the operations for purifying LEAD the great way. The ore is picked from among the traneous matter with which it was naturally mixed. is then pulverized and waſhed. It is next roaſted in a beratory furnace, in which it is to be agitated, till it ent all its ſides to the air; covered with charcoal, as as it is ſeen to be ſoftened to the ſtate of a paſte; with augmented heat, till the LEAD at laſt runs: then the running metal received through a perforation bottom of the furnace, into a proper receptacle, lined charcoal, below. The ſcoriæ remaining above in furnace, ſtill retain a conſiderable proportion of ; in order to the extraction of which, they muſt be in a blaſt furnace. To diſengage the ſilver from which has been thus far purified; the metal is jected to the action of the refining furnace. The of the bellows, there directed upon the fluid LEAD, it is, at the ſame time, urged by an intenſe heat, the metal into the yellow ſcaly oxyde, known by of *Litharge*. This ſcaly oxyde, being driven it is formed, leaves the ſilver alone in the midſt of The litharge is, then, to be fuſed in contact charcoal, that it may aſſume all the properties of pure LEAD.

4.
Characters of pure metallic lead.

, in this genuine purity, is the ſofteſt, the leaſt the leaſt ſonorous, the leaſt elaſtic, and one of ponderous of metals. Its colour is a duſky white; its ſpecific gravity is, according to Briſſon, according to Gellert, 11,445. It has a peculiar remarkable ſmell, which is rendered ſtronger by Its taſte is ſcarcely ſenſible to the mouth; but with a dangerouſly irritating energy on the nerves

of

of the ſtomach, and the inteſtines. It is ſuſcepti being beaten into thin plates, but acquires no new neſs nor denſity, under the hammer. A cubic LEAD weighs 828 pounds. It is ſuſceptible of a cryſtallization, and was obtained by Mongez, in qu gular pyramids lying on their ſides, and of thei faces, having one always larger than the reſt.

5. Action of Caloric upon Lead.

Its diſpoſition to yield to the action of fire is for a metal, conſiderably eager. It melts long being heated to ignition. A heat not too intenſ endured without injury by the naked hand, is ſuffi maintain it in fuſion. Of all the other metals, tin more fuſible. It does not even burn vegetable ſub with the loweſt heat, by which its fuſion may be Although it be little volatile, yet an exceedingly heat is capable of reducing it to fume, and evapora is by ſlow cooling, that it is cryſtallized into quadr pyramids, ſuch as were mentioned above.

6. Action of Oxygen upon Lead.

Melted in contact with *air*, it readily attracts from the atmoſphere. The oxyde thus formed, app a grey pellicle, covering the LEAD in fuſion. violent heat changes this grey pellicle into that d low oxyde, which is known by the name of Cooled by the effuſion of boiling water; ground fine powder, and in this form waſhed; expoſed fo and forty hours, to a moderate but ſteady heat furnace; paſſed through fine ſieves, into barrels pl receive it; it becomes *minium*, or red lead, ſuch largely manufactured in the county of Derby in In the courſe of this whole proceſs of oxydation, acquires ten per cent. of additional weight. A hea ntenſe than has yet been uſed upon it, will convert theſe oxydes into a yellow glaſs of extreme fuſibility.

7. Moiſture. *Moiſture* in an atmoſphere to which lead is expoſed, has a ſenſible action on the metal. A white ruſt is, by means of this moiſture, formed on the ſurface of the metal, and is from time to time carried off by the moiſture. This white ruſt is, however, nothing but carbonate of LEAD: For, *water* perfectly pure from extraneous mixture, has no power of action upon this metal. The internal ſides of leaden pipes uſed to conduct water, ſuffer a gradual oxydation: but, this alſo is effected, not by the water itſelf, but by the ſubſtances mixed with it. Hydrogen cauſes metallic lead to exhibit, on its ſurface, the changing colours of the rainbow.

8. Nitric Acid. The oxygen of concentrated *nitric acid*, is readily abſtracted by LEAD. A white oxyde of lead is almoſt inſtantaneouſly formed by the affuſion of the acid upon the metal. In a weaker ſtate of the acid, the oxydation is ſlower; the metal is firſt diſſolved in the acid, and the oxyde then appears in the form of flat triangles, having the angles truncated. By very ſlow evaporation, this ſolution affords cryſtals in the form of truncated hexahœdral priſms. This *nitrous oxyde* of LEAD, decrepitates in the fire, and upon ignited coals, is fuſed with a yellowiſh flame. By the continued action of the fire, the oxygen is expelled, and the LEAD reduced into a metallic ſtate. Sulphuric acid detaches the LEAD from this nitrous oxyde. Both oxygen and nitric acid, ſeem to enter into combination with LEAD, when it is oxydated by this acid.

9. Carbonic Acid. The native *carbonates* of LEAD, have been already mentioned. It is not uſual to attempt the artificial combination of carbonic acid with this metal.

As LEAD occurs in nature, moſt frequently in co nation with *ſulphur*, and ſometimes with ſulphuric aci ſo, its reactions with the acids of ſulphur, have been of

10.
ulphuric
Acid.

tried in the arts. When *ſulphuric* acid is boiled on LEAD; the LEAD is oxydated; and the acid, in con quence of its loſs of oxygen, is reduced from ſulphuric ſulphureous acid. In this remaining acid, there is, at ſame time, a partial ſolution of the metal, alſo oxyd Evaporation of the fluid mixture gives the oxyde in needles, or, in ſhort, tetrahœdral priſms, exceeding cauſtic, and ſoluble in eighteen times their own weigh of water. Theſe ſulphates of LEAD, are decompoſable by the action of heat ſingly, by lime, by alkalis, &c. Very hot *ſulphureous acid*, if poured into a leaden veſſ inſtantly corrodes and deſtroys it,

11.
hoſphoric
Acid.

Phoſpharic Acid is united with LEAD, as was about related, by natural combination. But, the re-actions of theſe two ſubſtances, have not been artificially exa mined.

12.
Muriatic
Acid.

Muriatic acid with heat, oxydates and diſſolves LEAD; but, never to the complete ſaturation of the acid. Of the muriate of lead, thus obtained, a part appears, from the firſt, in a ſolid oxyde; a part is diſſolved in the acid, from which ſtrong evaporation at laſt produces it, in fine brilliant needles. This ſalt is very ſlightly deliqueſcent in the air. It is decompoſable by lime and alkalis.—Muriatic acid poured on *litharge*, inſtantly decompoſes it. Heat to 50° or 60° is produced while the ſolution takes place. Octohœdral cryſtals of conſiderable weight, of an opaque white colour, and of a ſtyptic taſte, are obtained by evaporating the ſolution. Theſe cryſtals decrepitate on the coals, are deprived of their water of cryſtalyſtallization by an increaſed heat, and are thus reduced to a maſs of a beautiful yellow colour. At the temperature of 15°, this maſs is ſoluble in three times its own eight of water: boiling water diſſolves of it, a propor-ion ſomewhat more than equal in weight to itſelf. The ure alkalis precipitate the muriate of LEAD from theſe lutions, in a magma. The addition of the muriatic acid itſelf, or of almoſt any of the muriatic neutral ſalts, to a lution of nitrate of LEAD, produces a muriate of LEAD, in which the combination of the acid with the metal, is particularly ſtrong and intimate. Yet, the ſolution of that muriate of LEAD, which is known by the name of *Corneous* LEAD, is decompoſable by ſulphuric acid; a fact, which, contrary to what was once ſuppoſed, proves the affinity between LEAD and ſulphuric, and to be ſtronger than its affinity with muriatic acid.

13.
Acetous
Acid.

Acetous Acid corrodes LEAD, and produces by this ac-tion, the oxyde of LEAD, commonly known by the ame of *white* LEAD. The uſe of this ſubſtance in the rts, renders the preparation of it, a common object of anufacture. In this manufacture, plates of LEAD, half line thick, four or five inches wide, and two feet long, re rolled up in a ſpiral form, with interſtices of half an ch in width, between the rolls; they are next placed in es, upon projecting points prepared to receive them; alt-vinegar is poured into the pots, to the height of the wer edges of the LEAD; theſe pots are, in great num-ers, buried beſide one another, in beds of dung—and are ch covered with a plate and boards at the top: After maining in this ſituation for a month or ſix weeks, ey are taken out, and the white lead is ſeparated. It is en to be ground in mills, dried in the ſhade, and wrapped

wrapped up in papers for ſale. This is the whole proceſs of the manufacture. In the courſe of commerce there is a mixture of chalk added to the *white lead.*

14. Neutral Salts. With *nitrate of ſoda* LEAD produces no ſenſible detonation. LEAD with heat diſſolves *muriate of ammonia*, by detaching the acid. The artificial combination of *ſulphur* with LEAD, is a brittle compound of a plated texture, and a brilliant dark grey colour, much leſs fuſible than pure LEAD.

15. Other metals. Neither *nickel, manganeſe,* nor *cobalt,* unite, with LEAD, by fuſion. *Antimony* forms with it, a brittle mixture, with brilliant facets; in its colour and texture, not unlike to iron or ſteel, in ſpecific gravity; exceeding either of the two metals, of which it is made up. The combination of LEAD with *biſmuth,* affords a very brittle mixture, of a fine and cloſe grain. Hot *mercury* poured upon melted LEAD, gives an amalgam, white, brilliant, after ſome time ſolid, in trituration with the amalgam of biſmuth, liable to become as fluid as running mercury. Tin is combinable with LEAD by fuſion. An alloy, two parts tin, and one part LEAD, is more fuſible than either of theſe metals ſeparately, and is the common ſolder of the plumbers. Eight parts of biſmuth, five of LEAD, and three of tin, compoſe an alloy, fuſible by the heat of boiling-water. The alloy of LEAD with tin is the pewter which was long in general uſe in the manufacture of various utenſils for the kitchen and the table. Experience has evinced, that its uſe for theſe purpoſes is ſomewhat inſalutary; and tin perfectly pure, or at leaſt with a much ſmaller alloy of LEAD, is now univerſally preferred. ARSENIC fuſed in a ſmall proportion with LEAD, renders it more brittle than it naturally is.

16. Oxydes of Lead.

It is eaſy to perceive, that in all the preceding caſes of the combination of LEAD with acids, it is rather an OXYDE OF LEAD, than a diſtinct combination of the LEAD with the undecompoſed acid, that is produced. The acid is always partially decompoſed; and, the new ſalt ſeems to be always in part, the product of any oxydation. It is rather as containing oxygen, than from any other property that the nitric, muriatic, and ſulphuric acids poſſeſs ſuch power over LEAD. Yet, the ſalt which the acid ſolutions of LEAD yield by ſlow evaporation, are probably muriated nitrates, and ſulphates of conſiderable purity. The attraction between OXYDE OF LEAD, and the muriatic acid, is exceedingly ſtrong. A manufacture eſtabliſhed in England upon the knowledge of this fact, produces by the trituration of minium or litharge, with muriate of ſoda, a *muriate of* LEAD, of a fine yellow colour, which is valuable as a pigment; and at the ſame time furniſhes the *ſoda* in a ſeparate ſtate for the uſe of the glaſs-works, and for other arts. The pure *cauſtic alkalis* precipitate the OXYDE OF LEAD from its ſolution. In the acids in general, all the OXYDES OF LEAD are equally ſoluble as the metal itſelf. In theſe ſolutions, minium always loſes its colour. The OXYDES OF LEAD are all ſoluble in vinegar.

17. Uſes.

The uſes of LEAD and its OXYDES in the arts, are very numerous. Pipes for water, boilers, coverings for the roofs of buildings, linings of tea-cheſts, &c. are commonly made of it. It is caſt into bullets and ſmall ſhot. It has been too much uſed in the tinning of copper veſſels. Its ore pulverized and mixed with water, is uſed for glazing pottery. Its oxydes enter into the compoſition of glaſſes, cryſtals, and enamels. White LEAD and ceruſe

ceruſe mixed with oils, are much uſed as painters' colours. They are often noxious to the health of the workmen. The decompoſition of ſea-ſalt by litharge, and its ends have been already mentioned. Oxyde of LEAD diſſolved in vinegar, and commonly known by the name of *Sugar of Lead*, or *Salt of Saturn*, is in uſe among the callico printers. It is uſed, alſo, as an aſtringent waſh for burns, ulcers, and the remains of the venereal diſeaſe. It has, alſo, been nefariouſly and dangerouſly employed, to clarify liquors, and to ſweeten ſoured wines, and even vinegars intended to be ſold as wine. Oxyde of LEAD is uſed to harden oils, by encreaſing the proportion of oxygen in their compoſition. Oils uſed as the baſis of plaſters, contain a ſolution of LEAD.

SECTION

SECTION THIRTEENTH.

IRON.

1.
Native ores of IRON.

IRON is diffuſed throughout nature, perhaps more generally than any of the other metals. In animals, in vegetables, in all parts of the mineral kingdom, we detect its preſence. It is the general agent which produces all the diverſity of colours between the blue and the deepeſt red. Its ores are very much diverſified in ſpecies. Sometimes, the *pure* metal is found native; as has happened at Eibenſtock in Saxony, at Grand-Gilbert in the French province of Dauphiné, on the plains of Otumpa in Peru, and in the caſe of an enormous maſs in Siberia. It *often* appears in native *oxides*, of which ſome are black,—ſome of a greyiſh black,—ſome, a blueiſh grey,—ſome, a violet,—others, a browniſh red, &c. &c. A partial oxidation does not deſtroy that attractibility by the magnet, which is well known as a remarkable quality of pure IRON. The common, magnetic iron-ſtone, of which whole mountains are ſometimes compoſed; the magnetic ſand of various countries; ſpecular iron-ore: brown hæmatites; compact brown iron-ſtone; brown ſcaly iron ore; brown iron ochre; black iron-ſtone; red hæmatites; a fibrous iron-ore, which is very rare; compact red iron-ſtone; red ochre: red ſcaly iron-ore; are, all, ſo many ores in which this metal is mineralized by oxygen in various proportions. The native oxyde of IRON is contaminated with clay in common argillaceous iron-ſtone; in an iron-ſtone which is found in ſlender adhering

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columns of a dark browniſh red colour; in the ac iron-ſtone of Kirwan; in the nodular iron-ſtone, monly known by the name of ætites, and in o of its various native ores. In that which has been led *Siderite*, it is united with phoſphorus or with phoſ ric acid. Meadows, ſwamps, moraſſes, afford which have been called bog-ores of iron; in many of w phoſphorus and clay co-exiſt with the IRON. There a great diverſity of pyritical iron-ores, in which the is mineralized by ſulphur in various proportions. In iron-ores which have a ſpathoſe form, the IRON is ralized by carbonic acid. *Klaproth* has deſcribed was once miſtaken for a *native Pruſſian blue*, but w he denies to have this character,—under the name of *iron-ore of Vorau*. In two of its ores, IRON is miner by arſenic, and by the arſeniac acid. Emery is a co nation of IRON with Silice. In Sweden, there has found an ore, in which IRON co-exiſts with tung Plumbago or native carbure of IRON, is, as the name indicates, a natural combination of IRON carbon. As iron-ores are univerſally *diffuſed*, works have been eſtabliſhed in every country of Eu and in North America. Sweden exports much wr IRON to other countries. At Carron in Scotland, e ſive and very flouriſhing iron-works have been for a ſiderable time eſtabliſhed.

2. xtraction of IRON from its ores.

From theſe various ores, the pure metallic IRON, be obtained by the following aſſay, In the *dry* Take four hundred grains of calcined borax, forty of ſlaked lime, two hundred grains of nitrate of p and two hundred grains of the ore which you d aſſay. Pulverize this mixture; place it in a lined le; cover the crucible; expoſe the whole to the heat of forge furnace; after half an hour's ſubjection to this heat, the metal that was contained in the ore will be ound in a button, under the *vitrified flux*. In the *humid way*, ron-ores may be aſſayed by diſſolving the ore in muriatic id; and then precipitating the metal from the ſolution, adding a portion of alkali. When the ore is mixed other matters, the whole may be pounded, ſubjected the action of a ſtrong heat, the extraneous matters detached by the ſucceſſive actions of the nitrous and acitous acids, and the IRON finally diſſolved in *muriatic acid*.

In the working of iron-ores in the great way, various modes of purification are employed, according to the differences in the character of the ores. Of theſe, ſome need only to be pounded, waſhed, roaſted, and then put into the melting furnace. Argillaceous and and carbonated iron-ores require only to be melted in contact with charcoal. Peculiar furnaces, from twelve to eighteen feet in height; and having their internal cavity of the form of two four-ſided pyramids joined baſe to baſe; are employed in the fuſion of theſe ores. If the gangue of the ore be calcareous; no flux is added but a ſort of ſoft argillaceous ſtone: When it is argillaceous; the flux is a calcareous ſtone. The ores with the flux are put in at the upper part above the charcoal. Bellows or hydraulic machines are them employed to excite the fire. The ore melting, runs through the coal; and is purified as it paſſes. At the bottom it is collected, and maintained, for a while, in a fluid ſtate. At the end of every eight hours, this collected ore is ſuffered to flow out into a mould or hollow channel prepared in the ſand under the

furnace,

BOOK VII SECT. XIII furnace, to receive it. This firſt product is *crude* or *iron* A ſecond fuſion, during which it muſt be carefu ſtirred in the furnace; and then a proceſs under the forg hammer; are neceſſary to bring it into that ſtate of *iron*, in which the metal is ſuppoſed to appear with all proper qualities.

3. Characters of metalic iron. The IRON thus obtained, is of a white, livid colo inclining to grey. It is attractable by the magnet; fire with quartzoſe ſtones; is the lighteſt of all metals cept tin,—weighing only 545 pounds, a cubical foot. is of ſuch hardneſs and elaſticity as to to be capable, certain ſtates, of deſtroying the aggregation of all oth metals. it may be drawn out into wires, ſufficiently to become the ſtrings of muſical inſtruments. An wire one-tenth of an inch in diameter, is capable to tain a weight of 450 pounds. It is of all metals, gold, the moſt tenacious. It may be rendered ſtill by hammering without heat; when heated, it may made to aſſume under the hammer, almoſt every imagin able form. The texture of this forged-iron is fibroſe.

4. Actions of light and caloric upon iron. We know not that *light* alone has any diſtinct action upon IRON. *Heat* or *caloric* enters with great readineſs into this metal; is detained in large quantity among its parts; and does not without very conſiderable difficulty, expand them to fuſion. Its ductility and elaſticity are evidently much encreaſed by that caloric which it is capable of containing without being fuſed. Without being under the agency of caloric, it is incapable of amalgamation with any other metal.

5. Relations between iron and oxygen. The relations between IRON and *oxygen*, are very important. In every one of its three well-known ſtates of caſt iron,—forged iron,—and ſteel,—this metal contains

other

ces in a conſiderably intimate union with
t *caſt iron* contains always a proportion of
ertain; for this iron, when urged by an in-
cloſe veſſels, invariably yields carbonic acid;
ſe circumſtances, can be furniſhed only by
f oxygen expelled from the IRON with a
carbon that was alſo contained in it, and is,
ime, diſengaged. In *forged* or *bar iron*, too,
monly more or leſs of *oxygen*; though con-
than in *caſt* or *crude iron*. Were it not for
g other ſubſtances, IRON would be, of itſelf,
etal.

native ores of IRON are ſo often in a ſtate of
t is eaſy to ſee, that the mutual appetency of
xygen cannot but be conſiderable. A bar of
heated in the forge becomes oxydated at its
e pureſt IRON loſes its metallic brilliancy,
oxydated on the ſurface, by long expoſure to
ſphere. All the ruſtings of IRON utenſils,
e effects of oxydation. The famous decom-
water was firſt accompliſhed by the power
poſſeſſes of attracting the oxygen out of
when it is aided by the preſence of a certain
f caloric. The oxydes of IRON vary in co-
ng as their oxydation is more or leſs complete.
ly a part of the IRON is oxydated; in others,
wholly oxydated.

6.
Relations between iron and carbon.

, *iron* and its oxydes are often found in com-
h carbon: and carbon appears to exiſt in
on with it, in every one of thoſe ſtates in
ommonly uſed in the arts. In *caſt iron*, both
oxygen co-exiſt, in certain proportions, with

metal. In *forged iron*, the quantity of the oxygen ſent, is diminiſhed: that of the carbon, ſomewhat creaſed. In *ſteel*, there are no remains of oxygen, an augmented proportion of carbon. When the pro tion of carbon is ſtill increaſed to a great exceſs, the compound is that ſubſtance which is known by name of *plumbago* or *carbure of iron*.

7. Iron and phoſphore.

Of the *bog-ores* of IRON, many contain what was ſuppoſed a peculiar metal, and was named *ſiderite*. It been found to be either metallic or oxydated iron in with phoſphore, or with the phoſphoric acid. The phoric acid is not expelled by the proceſs which re the ore into the ſtate of *crude iron*. Its preſence in c nation with a part of the IRON, appears from peculiar c racters in ſuch crude irons as contain any portion They are of an unuſually coarſe grain, are harder and brittle than others, and are diſtinguiſhed by the name *red ſhort iron* and *cold ſhort iron*. Solutions of cold ſ *iron* in ſulphuric acid, have been found to afford a prec tate, which chemical examination has aſcertained to be a *phoſphate of iron*. This phoſphate of iron is decompoſ ble by the alkalis, and by lime-water, which detach the acid. Every ſolution of IRON, when treated with pho phoric acid, affords a precipitate of phoſphate of IRON.

8. Iron with ſulphuric acid.

Every acid has a more or leſs powerful re-agency up IRON. Concentrated *ſulphuric acid* is decompoſed by ebullition over IRON. Sublimated ſulphur, and a whi maſs incapable of cryſtallization, though in part, ſol ble in water, are the products obtained by diſtilling the mixture to dryneſs. Diluted ſulphuric acid, if pou upon IRON, yields with efferveſcence, a product of ga hydrogen from the decompoſition of the water; and the

ſolution

n, concentrated by evaporation, affords *ſulphate of*
This is the vitriol of commerce. It is often pro-
n manufacture, by an eaſy acceleration of the ſpon-
s decompoſition of martial pyrites. The pyrites is
broken and watered: The ſulphate of iron thus
off, is conducted in the water into proper reſer-
In theſe, the fluid mixture is left to concentrate Manufacture of Vitriol.
aporation: Old iron is thrown in, to ſaturate
cid with a ſufficient proportion of the metal:
uid is then drawn off into baſons having pieces of
properly diſpoſed in them; and in theſe the cryſ-
tion of the ſulphate of iron is finally accompliſhed.
cryſtals are rhomboidal: Their colour is a beau-
reen: They effloreſce in the air: They are reduced
u, to a powder;—and by a heat yet more intenſe,
prived of their acid, the eſcape of which leaves be-
only that metallic oxyde, known by the name of
har.

9. Iron with Nitric Acid.
en *Nitric Acid* is brought into contact with Iron;
id is diſſolved in part; and an oxyde of iron is
d. The oxyde remains, for a while, ſuſpended in
d ſolution. At laſt, it ſubſides to the bottom. A
uantity of iron immerſed in the ſupernatant liquor,
s the precipitation of the oxyde, and is itſelf likewiſe
ed. The concentration of the ſolution produces
hem, a martial ochre, of a red brown colour: And
oncentration, carried ſtill farther, gives a reddiſh
partly ſoluble in water. The *martial alkaline*
of Stahl, is obtained by precipitating the iron
his ſolution, with carbonate of potaſh.

10. Iron with Muriatic Acid.
ted *muriatic acid* acts upon Iron, with a vehement
. The decompoſition of the water of the diluted

acid

acid affords, for the firſt product, gas-hydrogen. Concentration and cooling reduce the remaining ſolution to a magma, containing a portion of thin, flat, very deliqueſcent cryſtals, Theſe are *muriate of iron* perfectly formed. Diſtilled, the whole magma affords,—firſt, an acid phlegm,—by a ſtronger heat, a non-deliqueſcent muriate of iron in ſublimation, with very tranſparent cryſtals, reſembling in form the blades of razors. and capable of decompoſing light, as well as the beſt priſms,—at the bottom of the retort, a ſtyptic, deliqueſcent ſalt, bright, foliated, and perfectly ſimilar to that large-plated talc, which is improperly denominated *Muſcovy-Glaſs*. The laſt of theſe products, when urged anew with a more intenſe heat, affords an opaque ſublimate of metallic iron, exhibiting ſections of hexahœdral priſms, with the poliſh of ſteel.

II. Tartareous acid; oxalic acid; gallic acid, &c.

Vegetable Acids poſſeſs, in general, the power of diſſolving IRON, and combining with it. By this property, is iron retained in the ſubſtance of living vegetables. The *tartareous acid* and *acidulum* hold it in ſolution, in wines, from which it may be precipitated by the addition of alkalis. Its ſolution in *oxalic acid* affords priſmatic cryſtals, efflореſcent by heat, ſoluble in water, ſomewhat aſtringent to the taſte, and of a greeniſh yellow colour. The *Gallic Acid* combines the moſt eagerly and remarkably with IRON. It holds iron in combination within thoſe living vegetables, in which it exiſts in the greateſt abundance; precipitates it from all its ſolutions; forms in ſeparate combination with it, a black powder; endows quinquina by its preſence together with a large proportion of iron, with its valuable medicinal qualities; and being commonly employed to precipitate iron from martial vitriol, thus furniſhes the valuable liquid,—*Writing Ink.*—Good

Writing Ink.

Writing

ing Ink is the preciſely ſaturated ſolution of Iron in
c Acid, ſo diluted, that it may flow eaſily from the
and containing perhaps a ſmall portion of gum, and of
uated carbon, to make it gliſter on the paper.

12.
Iron with
Pruſſic
acid.

ne *Pruſſic Acid*,—a compound, as is well known, of
ogen, carbon, azote, and oxygen in certain propor-
—and one of the moſt remarkable of the factitious
—gives a precipitate of a beautiful blue colour, by
action on IRON. This precipitate is well known as
ouring ſubſtance, by the common name of *Pruſſian*
. It is an exactly ſaturated *pruſſiate* of *iron*. When
is an exceſs of iron; the colour of the neutral ſalt
low. But this exceſs is taken away by any of the
acids.

13.
Earths,
alkalis,
&c.

ryt, *magneſia*, and *lime* are not known to act upon
. The *alkalis* diſſolved in water, and digeſted for
al days over iron, form a compound with it, which
alkaline oxyde of iron. In Art, as in Nature, the
n of *Sulphur*, *Phoſphore*, and *Carbon* with *Iron*, forms
ures, *Phoſphures*, and *Carbures* of Iron.

14.
Neutral
ſalts.
Nitrate of
potaſh.

mixture of equal parts of filings of STEEL and
e of potaſh, expoſed to the heat of a ſtrongly ignited
ble, is after ſome time decompoſed with detonation,
hich there is a conſiderable diſengagement of radiant
. In this chemical change, the power of the caloric,
the attractions of the iron for the oxygen of the
al ſalt, till that ſalt is decompoſed by the ſudden
ion of its oxygen in gas: That gas with another
ity from the atmoſphere, are again decompoſed to
ate the Iron, and to burn the carbon which was
mixed with it in the ſteel. It is by the combuſtion
he forcible eruption of this carbon, that the bright

ſparks

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ſparks are generated. Waſhing and filtration free the reſidue from the potaſh; leaving only a *yellowiſh oxyde of Iron*, which has been known by the name of *Zwelfer's Saffron of Mars*. *Sulphate of Iron* and *Nitrate of Pot-aſh* mutually decompoſe each other. The mutual attractions of potaſh and ſulphuric acid operate with conſiderable energy in this decompoſition.

15. ...riates. The ſtrength of the mutual attractions of Iron and *Muriatic Acid*, enables Iron to accompliſh the decompoſition of muriate of ammoniac. Two parts of ſteel filings with one part of muriate of ammoniac, diſtilled over mercury in a pneumato-chemical apparatus, afford a quantity of aeriform fluid, of which one half is gas ammoniac; the other half gas-hydrogen from the water of the ſolution; and a muriate of iron is, at the ſame time, formed. There is a compoſition called *Ens Martis* or *Flowers of iron*, which is formed by the mixture of ſteel-filings with Muriate of Ammoniac—in the proportion of an ounce of the former to a pound of the latter. In this compoſition the iron is oxydated; and the muriate of ammoniac is coloured by the oxyde; but there is no actual formation of muriate of iron. In conſequence of the continual tendency of muriatic acid to a ſtate of *ſuper-oxygenation*; the oxyde accompliſhes the decompoſition of muriate of ammoniac with greater energy than the pure Metal.

16. -hydro-n, &c. *Gas-hydrogen* only alters the colour of Iron. Powder of *ſulphur* and filings of ſteel produce Sulphure of Iron by a very rapid combination, if their re-actions be aſſiſted by the preſence of water. Heat is generated by the inteſtine action of this mixture, in the courſe of a few hours. The water is decompoſed; the ſulphur is acidified;

acidified ; the gas-hydrogen exhales ; and caloric is at laſt accumulated in ſuch a quantity, as often to make the mixture burn with flame. Theſe phænomena were firſt obſerved by Lemery, who ſuppoſed, with no ſmall plauſibility, that the origin of volcanos might be ſomewhat ſimilar.—*Carbure* of iron is combuſtible in conſequence of the great predominancy of *Carbon* in its compoſition.

17. Alloys.

With *arſenic*, IRON forms a brittle alloy which has been but little examined. It conſtitutes with *cobalt*, a cloſe-grained, hard, and powerfully coheſive, mixed metal. It is not known to be capable of union with *biſmuth*. Its alloy with antimony is hard, with ſmall facets, conſiderably refractory under the hammer. *Zinc* is at leaſt capable of being adheſively applied to the ſurface of a plate of Iron. The combination between *Nickel* and Iron, is ſo intimate, that, when formed together in Nature, theſe two metals are ſcarcely ſeparable by any agency of Art. No union is to be accompliſhed between *Mercury* and iron in their metallic ſtates.—*Lead* and iron do not enter into mutual union.—*Tin* and Iron are ſuſceptible of an amalgammation well-known in the arts. Its formation is a great Engliſh manufacture. Thin plates of the ſofteſt iron are, for this end, prepared : By friction with ſand-ſtones, acidulation with the fermented extract of malt, cleanſing, drying, and expoſure to be coated by volatilized ammoniac, theſe are fitted for being brought into adheſive contact with tin : They are then immerſed into a bath of melted tin which is covered with pitch or tallow : Withdrawn from this, they appear completely coated with the tin : The laſt part of the operation is, now, to wipe them with ſaw-duſt.

White Iron.

OK VII T.XIII 18. ſes of Iron. Innumerable are the uſes of IRON for the accommodation of human life. The poſſeſſion of ſkill to extract iron from its ores, and to manufacture it into utenſils,—or the want of this ſkill,—form the grand point of diſtinction between civilized and ſavage life. That native carbonated ore of iron which is diſtinguiſhed by the name of *plumbago*, forms excellent black lead pencils; is uſed in duſt, to lubricate certain inſtruments; ſerves, in a particular preparation, to defend iron from ruſting; is employed to glaze ſmall ſhot of lead, and for other uſes. *Crude Iron* is caſt in moulds for chimney-backs, pots, cauldrons, water-pipes, and a multiplicity of other uſes: The works for this manufacture at Creuſet in Burgundy, are much celebrated: There are very flouriſhing eſtabliſhments of the ſame ſort, at *Carron* in the ſhire of Stirling in Scotland, and on *Leith-walk* near Edinburgh. Sulphate of Iron is the baſis of all black colours, inks, &c. Hoematites, ochres, and ſome of the other ores of IRON are uſed in their native ſtate, as burniſhers, colouring matters, &c. Bar-iron is hammered out for a vaſt multiplicity of uſes in common life. Our cutting inſtruments are, all, made of ſteel. The oxydes of iron are uſed to colour porcelain, enamel, pottery, in the preparation of artificial precious ſtones, and in painters' oils. Iron alone of all the metals, is not noxious, but highly ſalutary, in its influence on the animal œconomy. It appears to enter more or leſs into the intimate ſtructure of almoſt all animals and vegetables. It is the beſt corroborative, of all medicines.—Its attractibility by the magnet renders it of ineſtimable importance in navigation.

SEC-

SECTION FOURTEENTH.

COPPER.

BOOK VII SECT. XIV

COPPER exiſts in Nature, in a perfect metallic ſtate, in mineralization by oxygen and carbonic acid, in native combination with ſulphur and other metals, in combination with muriatic acid, in union with arſeniac acid, and in a compound with metallic arſenic. Its colours, in theſe ores, are uſually ſhades of blue, red, green, and orange. It is ſometimes in the ſtate of unagglomerated earth; and ſometimes, in ſtones; ſometimes, in the forms of petrifactions, or ſtalactites; moſt generally, diſpoſed in metallic veins, in the bowels of the Earth. Pure native copper has been found in Japan, in compact maſſes. There are abundant copper-mines in England and in ſome parts of Scotland. In almoſt every known region, Copper-mines have been diſcovered. In many countries, they are wrought, and the copper purified for the uſe of life.—Turquoiſe-ſtones are the bones of animals coloured by copper: Malachite, mountain-green, mountain-blue are ſo many names for particular copper-ores. Copper pyrites is a form in which this ore is very generally diſperſed in the mines. The mine of Predanah in the county of Cornwall, affords a native oxyde of copper, of which the ſpecimens are very beautiful, and which is diſtinguiſhed by the name of *Red Copper Ore*. 1. Ores of Copper.

Of the ores of copper, ſome may be freed by ſimple fuſion, from the extraneous matters with which they are naturally mixed. Others are to be torrefied, and then fuſed 2. Aſſay of theſe Ores.

fuſed with three times their own quantity of black flux. Sulphureous copper ores are aſſayed by—pulveriſing two parts of the crude ore with one part of nitrate of potaſh; detonating the pulverized mixture in an ignited crucible; urging the detonized matter with greater intenſity of fire, till the ſulphur is diſſipated; increaſing the fire farther, to the fuſion of the remaining ore; adding a new mixture of tartar, ſalt, and charcoal, in ſucceſſive equal portions; ſtill increaſing the fire under the covered crucible: then, after half an hour of this greateſt intenſity of the heat, ſearching at [illegible]ſt for the metallic, malleable button.—In the *humid aſſay*, the ſulphuric and the nitric acids may be ſucceſſively employed; and the copper may be precipitated by iron, from the acid ſolutions of the ore.

3. Their purification in the great way.

In the *great way*, ores of copper are purified by a proceſs more operoſe. The ore is firſt picked, ſorted, pounded in a mill, and waſhed for the ſeparation of the gangue and other extraneous ſubſtances. Its mineralizer is then expelled by torrefaction. It is fuſed in a blaſt-furnace. The black metal which reſults from this firſt fuſion, is, then, again, fuſed in the refining furnace, to diſperſe the remaining ſulphur by which its colour was darkened. From this furnace, the melted metal is, after ſome time, poured into a broad veſſel, cooled on the ſurface with water, and thus in part rendered ſolid for particular examination. This copper is at laſt eſteemed fit for hammering. The roaſting or torrefaction is one of the moſt difficult of this ſeries of proceſſes; and is often to be performed for a number of times ſucceſſively.—After all this, whenever it happens that the copper is believed to contain a quantity of ſilver ſufficient to deſerve extr

s is to be employed. In this proceſs, ſeventy-five
unds of copper are fuſed together with two hundred
d ſeventy-five pounds of lead: The alloy thus formed,
caſt into flat pieces which are called *Loaves of Liqua-*
n: Theſe loaves are then expoſed to a heat ſufficient to
ſe the lead and in combination with it the ſilver, but
ot of ſuch force, as to overcome the refractorineſs of the
pper: The loaves, now called *Dried Loaves of Liqua-*
ion, are, next, in order to carry off the Lead and Silver
ore entirely, expoſed to the action of a ſtronger heat,
n a ſecond furnace. The Silver is afterwards ſeparated
rom the Lead, by fuſion in Cupels.

4. Characters of pure Copper.

The pure metal obtained by theſe proceſſes in the *ſmall*
r in the *great* way, is of a bright red colour; has an un-
leaſant ſmell which is rendered ſtronger by heat or fric-
ion; has a nauſeous, ſtyptic taſte, leſs ſenſible, how-
ver, than that of iron; is hard, elaſtic, ſonorous, of a
uctility which renders it reducible into fine wire or ex-
eedingly thin plates; has between eight and nine times
he ſpecific gravity of water; is of ſuch tenacity that
wire of copper one-tenth of an inch in diameter, will
uſtain a weight of 299¼ pounds; is ſuſceptible of cryſ-
allization into quadrangular pyramids; weighs, each cu-
ic foot, 545 pounds.

5. Influence of atmoſpheric air on copper.

Long expoſure to the mixed *airs, moiſture, and ſalts of*
he atmoſphere, alters the ſurface of this COPPER into a
ard greeniſh coating, well known to Antiquarians, by
he name of *Patin*. *Cold* water has greater power than
hat which is hot, to diſſolve copper.

6. Light and Caloric.

The ſolitary action of *Light* upon COPPER is not
known. In the *fire*, the power of *Caloric* makes it be-
come, firſt, blue, then yellow, at laſt of a violet colour.

Strong

Strong ignition is neceſſary to bring it to fuſi contact with burning coals, it gives a blue greeni to the flame. If held long in fuſion, it is parti latilized. Heated in contact with air, it attracts with ſuch force as to burn at the ſurface ; and converted into a blackiſh red oxyde. If Copper b ly cooled from a ſtate of fuſion, ſo as to congea ſurface, while a part ſtill remains fluid below ; an which is ſtill fluid be then poured off ; it affords, ſlow cooling, quadrangular cryſtals, which ap thoſe parts where the congealed copper was in with the copper ſtill in fuſion.

7. Nitric Acid. *Nitric Acid* oxydates COPPER with an ener rapidity which occaſion the diſengagement of th with efferveſcence. The acid muſt be ſlightly we to prevent the change from taking place with in nient violence. Nitric acid more conſiderably produces a *nitrate of copper*, by accompliſhing a ſolution of the metal. The ſolution rapidly conce *affords* the ſalt in an uncryſtallized magma. By ration, it gives the ſalt in parallelogrammatic In ſome inſtances, the cryſtals have been rho and of a white colour, not blue—as they are mo monly deſcribed. They decrepitate upon coals ; a red gas, and leaving a reſidual grey oxyde.

8. Carbonic Acid. It is probable, that, at leaſt in the atſmoſphe *bonic acid* contributes to the oxydation of COPP aiding the action of moiſture, and of the azotic a genous gaſes.

9. Sulphuric Acid. *Sulphuric Acid* when concentrated, and aided preſence of much caloric, has the power of di copper. This ſolution affords,—by immediate

ion, long rhomboidal cryſtals of ſulphate of copper, of a beautiful blue colour,—by ſpontaneous cooling, ſimilar cryſtals, together with a precipitated green oxyde. This ſulphate of copper is a ſalt common in commerce. But, in the great way, it is differently manufactured. It is procured either by burning, efflorеſcence, and lixiviation from native cupreous pyrites,—or by a ſimilar ſeries of proceſs from a factitious cupreous pyrites, formed for this expreſs uſe. It is a powerfully ſtyptic ſalt; eaſily fuſible by heat; decompoſable by intenſity of fire, by lime, magneſia, and ammoniac; containing in the hundred pounds, thirty of acid, forty-three of water, twenty-ſeven of copper.

Copperas.

10. Muriatic Acid.

Muriatic Acid, concentrated and heated to ebullition, has, alſo, the power of diſſolving Copper. The ſolution is green, and affords by ſlow evaporation, conſiderably regular cryſtals. This ſalt is deliqueſcent; of a graſs-green colour; cauſtic and aſtringent to the taſte; fuſible by a gentle heat; and, after fuſion, liable to congeal to a maſs, from which the acid is not ſeparable, but by a great intenſity of heat.

11. Acetous Acid.

Acetous Acid, whether hot or cold, acts upon COPPER, only with energy ſufficient to corrode it. The ſalt thus formed, is an *acetite of copper*, and is known in commerce by the name of *Verdigris*. It has long been manufactured at Montpelier—by—placing the refuſe of grapes, after its fermentation with ſour wine, in alternate ſtrata with plates of copper, ſix inches in length, and one inch in breadth; leaving theſe matters, for a certain time, in this ſtate; then, depoſiting the plates of copper on the edges, in a cellar, with the intermediate layers of the refuſe of grapes; ſprinkling the whole with ſour wine; and

Verdigris.

and ſcraping off the verdigris, as it ſwells up; which is now only to be put aſide in leathern bags for exportation. The affuſion of vinegar upon plates of copper, produces, alſo, a verdigris; which is, however, an *acetate*, not an *acetite*, of copper. The ſolution of the *oxydes of copper* in vinegar affords a cryſtallized *verdigris* which is *Acetate of copper*. In preparing this ſalt; a weak vinegar from wine-lees, is boiled on the oxyde; the ſolution is then concentrated in a boiler, till a pellicle appears on its ſurface; ſticks are immerſed in the bath: at the end of a certain number of days, theſe ſticks are found to be covered with blue rhomboidal cryſtals. Each cluſter of theſe cryſtals, is uſually from four to ſix pounds in weight. They are, now, fit to be put up for ſale. Diſtillation will deprive them of their vinegar; leaving only a reſidue of pyrophorous oxyde of copper.

12. Earths and Alkalis. *Baryt*, *magneſia*, and *lime* are not known to act upon copper. *Potaſh* and *ſoda*, if digeſted, cold, on filings of copper, aſſume, after a certain time, a light blue colour, and cauſe the copper to exhibit, on its ſurface, a powder of the ſame colour. *Ammoniac* diſſolves COPPER, with a much more powerful energy. Filings of copper, digeſted with ammoniac, produce, within a few hours a new ſalt of a beautiful deep blue colour. After digeſtion for a number of months, and many intervening changes, a blue and a brown ſalt, in a pretty large proportion, are exhibited in the phial in which the mixture is kept. By ſlow evaporation, this ſame ſolution affords beautiful cryſtals, not unlike to the native azure of copper. Acids do not precipitate the Ammoniacal Solution of copper, but only change its colour from blue to a very pale green. All the oxydes of copper are eaſily ſoluble in ammoniac:

and

ry beautiful blue colour immediately appears, in
ence of the ſolution. The uſe of ammoniac has,
e, been propoſed, as a teſt to detect the preſence
er wherever its exiſtence is ſuſpected; for even
lleſt portion of the metal is received into com-
with the alkali.

13.
Precipitation of Copper from its Acid ſolution, by Iron.

having ſtronger attractions for the Acids, than
, precipitates this laſt metal from all its ſolutions.
on of ſulphate of copper, poured, for inſtance,
e clean ſurface of a piece of iron, inſtantly covers
ace with copper.

14.
Copper and neutral alkaline ſalts.

s of COPPER caſt upon *Nitrate of potaſh* in fu-
large crucible, decompoſe it with a ſlight mo-
d with the emiſſion of ſmall flaſhes. A browniſh
ith a mixture of potaſh, are the fixed reſidue, re-
at the end of the proceſs, in the crucible. Waſh-
ies off the alkali, and leaves the metallic oxyde,
ſt flows, without addition, into a glaſs of a deep
olour, which is uſed in colouring enamels. *Mu-*
mmoniac is eaſily decompoſable by copper. Gas-
ac, gas-azote, gas-hydrogen from the water of
tion, and a fixed reſidue of muriate of copper,
reſults of this decompoſition. A ſolution of *ſul-*
alum, boiled in a copper veſſel, depoſites a ſmall
of clay: And it ſhould, therefore, ſeem, that
poſſeſſes, in a ſlight degree, the power of decom-
this ſalt. The *Oxyde of copper* is reducible by
ogen, which abſtracts its oxygen, to form water.
a compound of ſulphur with copper, which ſerves
, for the painting of calicoes. *Sulphures* diſſolve
both in the dry and in the humid way.

The

15. Alloys of copper other metals. The alloy of COPPER with *arſenic*, affords that mixed metal which is known by the vulgar name of *white tombac*. Its alloy with biſmuth is of a reddiſh colour with cubic facets. In combination with antimony, it gives an alloy of a violet colour. With zinc it forms by fuſion or cementation, the *Lapis Calaminaris*; the reſult of the fuſion, being that ſort of Lapis Calaminaris Braſs. which is called *Similor* or *Manheim Gold*; the product of the cementation, braſs.—A plate of copper plunged into a quantity of mercury in fuſion, takes up ſo much of the mercury, as is ſufficient to make it aſſume a white colour.—Copper is ſuſceptible of being coated with *tin*: An operation which is performed—by clearing the inſide of the copper veſſel with muriate of ammonic, with a weak acid, or with ſcraping,—fuſing the neceſſary quantity of tin in the veſſel,—and ſpreading it, thus fuſed, with old rags. Pitch is applied to hinder the oxidation of the metals thus united. By fuſion with tin, copper af-Bell-metal. fords *bronze* or *bell-metal*. The greater the proportion of tin; ſo much the more brittle, white, and ſonorous, is this alloy. *Lead* and copper are united by fuſion, in the loaves of liquation, above mentioned. Copper and *iron* are brought with extreme difficulty, into a ſort of imperfect union. The alloy of copper with *ſilver* is more fuſible than pure copper. Theſe two metals are united to form ſolders. Copper precipitates ſilver from its ſolution in *Nitric Acid*.

16. Uſes of Copper. Copper is uſed, in the Arts, to ſheathe ſhips; to form boilers for dyeing-houſes and bleach-fields; to form our baſeſt coins; in kettles, and ſome other domeſtic utenſils. Its alloys with biſmuth, zinc, and tin, are applied to a multiplicity of uſes. Its oxydes and combin

the acids afford dyers' and painters' colours. The formation of theſe ſalts in copper veſſels, and their ive noxiouſneſs to the Animal œconomy, have oc-ed copper to be ſuperſeded, in a great meaſure, by n-ware, caſt-iron, and tinned iron, in the manu-s of utenſils for the kitchen and the table, in every ry in which pernicious cuſtom and the artifices of have not more influence than a due regard to the of the people.

SECTION FIFTEENTH.

SILVER.

BOOK VII
Sect. XV.

1.
Ores of ſilver.

Silver is found in Nature, in a conſiderable diverſity of forms. It is ſometimes native, in its pure metallic ſtate; in which it appears—in ſeries of octohædrons inſerted in one another,—in ſmall, capillary, flexible threads intwined together,—in plates,—or in maſſes. There is a native alloy of ſilver with gold, in *filiform*, reticular, or ſpangled ſpecimens of a yellowiſh white colour. There is a cupriferous native Silver, in which the proportion of the copper is ſcanty, and the aſpect of the ore little different from that of the pure ore of ſilver. In certain whitiſh ores, the ſilver is mineralized by a proportion of antimony: The ſpecimens are irregular grains, lumps, or priſms. There is a grey ore of ſilver, ſuſceptible of being cut like lead, capable of regular cryſtallization, but often in lumps of uncertain form, in which the ſilver is mineralized by ſulphur. There is an arſenico-martial ore of ſilver, of a dull white colour, a foliated fracture, ſometimes in ſix-ſided priſms, or in truncated pyramids, oftener in irregular lumps. There is a maſſive, greyiſh black ore of ſilver, in which the ſilver is combined with carbonic acid, and with the oxydes of antimony and copper. There is a corneous ſilver in which Muriatic Acid is the mineralizer. There is a ſoft ſilver ore in which the ſilver is aſſociated with argillaceous earths. A native combination of ſilver with biſmuth has been recen

diſcover

ſcovered in Saxony. Silver often exiſts in ſmaller proortions, in the ores of cobalt, nickel, lead, antimony, opper, in various ſtones and earths, and even in ſome ganized bodies. Germany, and other countries of Euope, but more eſpecially Peru and Mexico in South merica, contain ſilver mines, and afford theſe different res of ſilver in the greateſt abundance. There are alſo ver-mines in Ireland, in Norway, in France, and in any other parts of the world.

2.
Aſſay of ſilver.

The following is a mode of aſſaying the purity of ILVER. Take thirty-ſix grains of the metal: wrap eſe in a plate of lead; then expoſe the whole to cupellation:—The button of pure ſilver remaining, after the proceſs, in the cupel, will ſhew by the compariſon of its weight with that of the ſilver at firſt employed, what proportion of pure metal, that ſilver contained. This is a mode of aſſay for ſilver already wrought.

3.
Purification of ſilver ores.

Different modes are employed in different countries, to purify ſilver ores. In Mexico and Peru, the mineral is pounded, roaſted, waſhed, then triturated with mercury in copper boilers full of boiling water. A ſort of mill is employed to keep the whole in agitation. The amalgam is afterwards preſſed in a ſkin: Heat is applied to drive off the remaining mercury: The ſilver is, thus, at laſt, obtained pure.—But, in this mode of operation, there is too great a waſte of the ſilver.——Silver ores mineralized by ſulphur, are eaſily purified by roaſting, pounding, waſhing, fuſion with lead, and cupellation.——Poor ores of ſilver are to be fuſed with cupreous pyrites; and the mixture thus produced, is then to be treated in the way of *Eliquation*,—the lead and ſilver being ſeparated from the copper by ſucceſſive roaſtings,—and then from on ther by fuſion in cupels.

4. Characters of pure ſilver.

Silver thus purified, is of a brilliant white c without taſte *or ſmell*; little alterable by fire; of b ten and eleven times the ſpecific weight of water; ing about 712 pounds, each cubic foot; of a d that makes it ſuſceptible of being beaten into lea which a grain meaſures 51 ſquare inches,—and into wire about $\frac{1}{750}$ part of an inch in diameter, the diameter of a fine human hair; of ſuch tenaci a wire of one-tenth of an inch in diameter, will ſu weight of 270 pounds; leſs ſonorous, hard, and than copper; liable to become harder under the ha but ſoften by heating; cryſtallizable into quadra pyramids, either ſolitary, or in groupes in which th mids are diſpoſed, laterally, one over another.

5. Action of the atmoſphere on ſilver.

By the *Atmoſphere* or by *Light* alone, this metal liable to be altered.

6. Action of caloric on ſilver.

It is not fuſible, unleſs ſubjected to a very ſtron It has been volatilized, without alteration, in the the focus of Trudaine's lens. In this volatilizatio metal riſes in thick fumes, and fixes, in a white cr plates ſubjected to receive it. Silver has been vitri Junker, in a ſtrong reverberatory heat. Macquer a obtained from ſilver expoſed twenty times, ſucceſſiv the porcelain furnace of Seves,—a glaſs of an olive colour. In the focus of a burning mirror, ſilv been obſerved to preſent, on its ſurface, a whi verulent matter, and to depoſite a greeniſh vitreous ing, on the ſupport that ſuſtains it. From theſe f is evident that metallic ſilver is indeed capable of *ox*

n contact with air containing gas-oxygen,—yet not
it extreme difficulty. The mutual attraction be-
SILVER and *oxygen* is, therefore, not ſtrong.

7.
Of Gas-hydrogen.

-hydrogen ſeems to have a conſiderably ſtrong at-
n for SILVER. All ſilver ſurfaces are quickly tar-
by this gas, and by every compound, from which it
y diſengaged.

8.
Of Sulphur and its compounds.

hur eaſily combines with SILVER. The combina-
artificially effected by ſtratifying plates of the metal
ulverized ſulphur, and fuſing this mixture, rapidly.
maſs of a deep violet-colour, brittle, needled, much
ſoluble than pure ſilver. It is eaſily decompoſed by
hich, volatilizing and diſſipating the ſulphur, leaves
ver pure. Sulphures eaſily diſſolve ſilver in the dry
One part of ſilver, mixed with three parts of an al-
ſulphure, gives a mixture, in which the ſilver has en-
liſappeared, which is ſoluble in water, and affords
he ſolution, by acids, a black ſulphureous precipitate
r. It ſhould ſeem, that ſilver is capable of detaching
phur from the alkali in thoſe alkaline ſulphures.——
ric Acid poured on ſilver, oxydates the metal, and
out, during the proceſs, a large proportion of ſul-
us acid-gas. With the oxyde, there is formed a
roportion of ſulphate of ſilver, which is obtained in
, or in needled plates.

ric Acid diſſolves SILVER with great energy; giv-
t, while the ſolution is effected, a large proportion of
gas. The ſolution is, at firſt, blue,—and if the ſilver
taminated with copper, green: but the Colour af-
ls diſappears from the pure ſolution. It depoſites, by
g, hexangular, triangular, or ſquare plates of Nitrate
r. The reſt is an oxyde of ſilver. The nitrous ſo-

lution

BOOK VII. SECT. XV.

lution of ſilver, colours the ſkin black, and by its [illegible] to give out oxygen, actually deſtroys the epidermis. [illegible] burning coals, nitrate of ſilver melts. By a gentle [illegible] earthen or metallic veſſels, it is liquefied, and [illegible] to be caſt in moulds. Into theſe, it muſt be poured [illegible] moment it is fuſed. The ſubſtance thus produced is [illegible] garly known by the name of *Lapis Infernalis*, [illegible] whitiſh colour, and a powerful cauſtic. The [illegible] precipitable from the ſolutions of the *Lapis Infernalis* [illegible] lime-water, alkalis, and ſeveral metals. [illegible]

9.
Of Nitric and Muriatic Acids.

The *Oxygenated muriatic acid* diſſolves [illegible] An oxyde is the product of the ſolution,—together [illegible] ſmall proportion of true muriate of ſilver. *Nitro-*[illegible] *acid* diſſolves ſilver, and precipitates from the [illegible] muriate of ſilver.

10.
Of Neutral Salts.

The *neutral ſalts* in general, have but little [illegible] upon SILVER. *Nitrate of potaſh* has leſs power over [illegible] than over any of the leſs precious metals: [illegible] tion with nitrate of potaſh, is therefore, a good [illegible] the ſeparation of ſilver from an alloy of baſer metals.

[illegible]

The *alkalis* and *ſaline-terrene* ſubſtances have little [illegible] of reaction upon ſilver.

[illegible]

SILVER unites readily with *arſenic*; and the reſult of [illegible] union, is a brittle mixture. With *cobalt*, it does not [illegible] combine. It forms by an eaſy combination with [illegible] a brittle mixed metal, of which the ſpecific [illegible] greater than that of either of the two ſubſtances of [illegible] it is compounded. SILVER enters not into [illegible] [illegible]: But, when theſe two metals are melted [illegible] they remain beſide each other, as if their ſpecific [illegible] were perfectly the ſame for both. The fuſion of [illegible] with pure *antimony* gives a very brittle alloy. [illegible]

[illegible]

timony is decompoſed by ſilver, which detaches the ſul-fur. *Zinc* combines, by fuſion, with ſilver, to produce very brittle mixture, granulated at the ſurface. By the ituration of ſilver leaf with *mercury*, there is formed an algam, of which the conſiſtency varies with the pro-rtions of the two component ſubſtances: By ſubſequent ſion and ſlow cooling, this amalgam affords tetrahœdral ſmatic cryſtals, terminated by pyramids of the ſame m. It ſhould ſeem, that, in this combination, the mer-y aſſumes a degree of fixity: for, it is leſs eaſily ſepa-ed from the ſilver, than volatilized, alone. Silver unites, twiſe, with *tin*; but loſes its ductility by this union.—enters into a very fuſible alloy with *lead*; in which it however, deprived of its ductility and ſonoroſity.—Its y with *iron*, has not, as yet, been much examined; may, hereafter, become highly uſeful in the arts.—ith *copper* it combines in all proportions, thus forming a y uſeful alloy.

13.
Oxydes of ſilver by nitric acid, &c.

The OXYDE OF SILVER merits yet more particular ention. It is only the extreme intenſity of heat, that enable this metal to attract oxygen from the atmo-ere. In all its combinations with the acids, however, more or leſs oxydated. Lime-water, alkalis, and ſe-al of the metals precipitate ſilver from the nitrous ſo-on of its oxyde. A plate of *copper* immerſed in this ous ſolution, precipitates the ſilver, and gives a nitric tion of copper of a blue colour. *Mercury*, too, at-the ſilver into amalgammation with itſelf, from this ſolution of the oxyde: A ſmall quantity of mercury to a nitric ſolution of ſilver, gives the ſilver in a of vegetative figure, which conſiſts of tetrahœdral s; terminating in a tetrahœdral pyramid, with an articulation of the cryſtals into one another. The muriatic *oxyde* of ſilver becomes quickly brown by expoſure to the ſolar light, and at the ſame time, gives out gas-oxygen. Of the muriate of ſilver, which ſeems to be, always, in part, an oxyde, boiling water does not diſſolve above three or four grains for every pound of the fluid. It is decompoſable by the alkalis which detach its portion of genuine muriatic acid. The ſlightneſs of the combination between ſilver and oxygen, renders it poſſible to form with the *nitrous oxyde* of this metal, one of the moſt dreadful and aſtoniſhing fulminating powders hitherto known to us. A portion of the fineſt ſilver is to be diſſolved in nitric acid; precipitated from this ſolution by lime-water; left dry by the decantation of the water; expoſed for three days to the influence of the air and the light; mixed with ammoniac, till it take the form of a black powder; then dried, finally, in the open air. This product, brought into this ſtate, is the fulminating powder invented by *Berthollet*, of which the effects are the moſt forcible and extraordinary. It has been called *fulminating ſilver*. The contact of fire is not even neceſſary to produce its detonation. It kindles and explodes of itſelf. Its very preparation is ſo dangerous to the operator, that it is not to be ſafely attempted, without a maſk with glaſs eyes, upon the face.—In this fulmination, the hydrogen of the ammoniac combines with the oxygen of the oxyde of ſilver: Water is formed, and in its formation expanded into vapour. The eager action of the attractions between hydrogen and oxygen; and the exceſſive expanſion of the water which they form; are the cauſes of the detonation.—The ſilver is found after this phœnomenon, to have reſumed its me-

…the OXYDES, [illegible]

14. Uſes of Silver.

…ts averſion from any very
…render it highly uſeful in the
…ncy makes it eligible for many
…indeſtructibility by air and fire
…al for the compoſition of domeſtic
…coinage, as a precious metal [illegible]
…own intrinſic value, to become a repre-
…the value of other commodities. In the
…ge, it is uſually alloyed with a certain
…pper, to augment its hardneſs. In the
…age, the ſilver is 11 ounces, 2 penny-
…e remaining portion of each pound, being
…e; the uſual alloy of copper, in the ſilver
one-twelfth part. In the ſolder uſed to
of ſilver utenſils, the proportion of cop-
eater, that ſuch veſſels are apt to ex-
…tis at the places where they are ſol-
…ers produce bad ſilver money, either
ſilver with copper, in which the pro-
is below the true ſtandard,—by em-
ſilver with zinc, arſenic, or biſmuth,
…vering plates of copper with ſilver.

SECTION

SECTION SIXTEENTH.

GOLD.

BOOK VII Sect. XVI

1. Ores of Gold.

GOLD is often found in Nature, perfectly pure, in various forms and in different gangues. In the gold mines of Boitza in Tranſylvania, it has been met with in octohedrons truncated ſo as to have the appearance of hexagonal plates. In thoſe of Legardet, near Allemont in Dauphiny, it has been found in filaments, and in plates diſſeminated on a gangue. It has been found in ſmall plates and ſpangles in earths and in the ſands of many rivers. It is found, alſo, in irregular, uncryſtallized maſſes; a form in which it has the appellation of *Gold-duſt.* The largeſt piece of this ſort that has, hitherto, been diſcovered in Europe, was found in the county of Wicklow in Ireland: Its weight was no leſs than two and twenty ounces. It is often in alloy with ſulphur. There is, alſo, known, an arſenical ore of gold. It has been extracted—from an argentiferous copper pyrites, called in Hungary, *Gelf,*—from the mixed ſulphurated ores of Nagaya in Tranſylvania,—and by Becher and Sage, from the remains of putrefied vegetables, or *vegetable mould.* M. Berthollet and other French chemiſts have obtained gold out of aſhes, in the proportion of 40 $\frac{8}{25}$ grains of gold from the cwt. of the aſhes.

2. Extraction of Gold from its Ores.

Gold, rarely exiſting in its ores, otherwiſe than in a metallic form, is extracted by a proceſs not very difficult to be explained. That which is called pure *Native Go*

ground, waſhed, triturated in a mortar with water
n or twelve parts of mercury, freed by decantation
the water, preſſed in bags of chamois leather through
i moſt of the mercury eaſily paſſes, then cleared by
tion from whatever mercury, it may happen ſtill to

From the *ores* of *lead and copper*, gold is extracted
pellation, eliquation, and the proceſs of parting.—
i embodied in *earths or ſtones*; gold may be ſepa-
in the *humid aſſay*, by diſſolving the powdered
—if it be calcareous, in Nitric Acid,—if it be ſili-
by digeſting it in nitro-muriatic acid;—and then
tating the gold with the diluted ſolution of iron.
e earth or ſtone in powder may be amalgammated
ix times its own weight of mercury, in a proper veſ-
i which it is to be agitated with the mercury made
ad with ſucceſſive additions of boiling water,—till
rcury ſhall take up the gold; which may be after-
ſeparated from it by diſtillation.——*Baron* BORN has
d all the operations for purifying the ores of both
ad gold to the following ſimple proceſs. 1. Pound,
ſift the mineral: 2. Let it be properly roaſted:
e it with muriate of ſoda, water, and mercury, and
it, to facilitate amalgammation: 4. Expreſs the mer-
om the amalgam: 5. Diſtil the expreſſed mercury:
ine the metal by cupellation. ——After this cupella-
he gold may ſtill contain ſilver, which is to be ſepa-
y ſolution with concentrated nitric acid, in a heated,
tion of the ſolution, a new addition and decantation
ſtronger acid, and finally, waſhing with hot water,
water ſhall come off taſteleſs. Even after this pro-
e gold ſtill retains a very ſmall proportion of ſilver,
annot be entirely detached from it.

Pure

BOOK VIII. SECT. XVI.

1. Characters of pure Gold.

Pure GOLD, thus obtained, is the moſt perfect, and the leaſt alterable of metals. It is of a yellow, brilliant colour; is of all known ſubſtances, except platina, the heavieſt—loſing only between one-nineteenth and one-twentieth part of its weight in water; is ductile to ſuch a degree, that an ounce of gold is ſufficient to gild a ſilver wire 444 leagues in length, and that it may be reduced into plates ſufficiently thin to be blown about by the wind; is of all metals the moſt tenacious, ſo that a gold-wire one-tenth of an inch in diameter will ſuſtain a weight of 500 pounds; becomes hard under the hammer, but recovers its ductility by ignition; poſſeſſes no conſiderable natural hardneſs or elaſticity; is cryſtallizable by cooling, into ſhort quadrangular pyramids.

4. Action of [illegible] Gold.

GOLD expoſed to the action of FIRE, firſt becomes red-hot; then, in a ſtrong heat aſſumes a bright ſea-green colour; at laſt, after being heated to whiteneſs, melts. The ſtrongeſt heat of a furnace, however long applied, does not alter gold. But, Homberg found, that in the focus of the lens of Tſchirnhauſen, this metal would fume, volatilize, and vitrify. Macquer made gold to exhibit ſimilar phœnomena in Trudaine's burning mirror.

GOLD undergoes not alteration by expoſure to air or light. The depoſition of extraneous ſubſtances may change its exterior appearance: But, no new combination is effected.

Water is capable of effecting an extreme comminution of the particles of GOLD, and of holding it in ſuſpenſion. But, this action is merely mechanical. No chemical change is, by this agent, accompliſhed upon the metal.

[illegible] is as little capable of chemical reaction upon [illegible]. But, as this ſubſtance poſſeſſes a different power over wer other metals ; the uſe of it has been propoſed for the ſeparation of ſilver in particular, from its alloy with gold. But, the ſeparation is imperfect; and this expedient is employed, only where the maſs is too poor for a more expenſive proceſs. There is no reaction between Gold and *ſulphuric acid*, in any ſtate of the acid.

8.
Nitric
Acid.

Very pure *nitric acid* is capable of diſſolving GOLD in ery ſmall quantity, under the agency of cold. Pure nitric cid boiled upon gold, effects a ſtill more evident ſolution f the metal. The weight is in this proceſs, unqueſtionbly diminiſhed: The evaporation of the acid leaves a ſidue of gold or oxyde of gold: And the immerſion of a lver plate into the ſolution, parts the gold from it, in the rm of a black, woolly depoſit. The quantity of the id, the time of the ebullition, and the particular thickſs of the metallic body, occaſion variations in the quany of the compound produced by this ſolution.

9.
Compound
Muriatic
Acids.

The only very powerful ſolvents of GOLD, are, the ro-*muriatic acid* and the oxygenated muriatic acid. Oxyted muriatic acid highly concentrated, poured upon a ſurface of gold, and aided in its operation, by the ence of heat, diſſolves the gold with conſiderable energy, d without any ſenſible effervefcence. The nitro-muriatic , concentrated, and brought into contact with gold, in gh temperature, and with the metal in a ſtate of ex diviſion, diſſolves it with great effervefcence, and es out nitrous gas during the ſolution. Saturated with uch gold as it can take up, this acid is of a yellow r more or leſs deep, conſiderably cauſtic, having power orrode animal matters, and to tinge them of a deep ple colour, It affords, by cautious evaporation, cryſtals beautiful yellow colour, not unlike to topazes, and conſiſting

conſiſting ſometimes of truncated octohœdrons, ſometimes of tetrahœdral prisms. This cryſtallization is, however, not always to be obtained: Bergman conſiders theſe cryſtals, not as an oxyde, but, as a true muriate, of gold Similar cryſtals are afforded from the oxy-muriatic ſolution.

10. Other Acids. None of the other acids are known to act upon gold not in ſolution.

11. Lime and Magneſia. *Lime* and *magneſia* precipitate GOLD from its nitro-muriatic or oxy-muriatic ſolution, by detaching the muriatic acid and moſt of the oxygen. The precipitate is a yellow powder which, by the aid of a ſlight heat, becomes perfect metallic gold.

12. Alkalis. ALKALIS precipitate GOLD from its muriatic ſolution, in a yellowiſh powder, ſoluble in ſulphuric, nitric, or muriatic acid. Concentrated, theſe laſt ſolutions ſuffer the gold to precipitate. It has never been obtained from them, in cryſtals. *Ammoniac* poured on a yellowiſh ſolution of gold, gives a woolly precipitate; which, when dried in the ſhade, becomes what is called *Fulminating Gold*. This *Fulminating Gold* detonates, when gently heated. It is ſimply a mixture of oxyde of Gold with Ammoniac: For, if gently rubbed in a copper tube, the end of which is, by means of a ſyphon connected with a pneumato-chemical apparatus; it gives out gas-ammoniac, and becomes incapable of fulmination: The action of a heat lower than that which makes it fulminate, will, alſo, deſtroy its fulminating power, by driving off the gas: If fulminated in tubes of which the extremities are inſerted in veſſels filled with mercury; it affords a product of gas nitrogen, with ſome drops of water: By trituration with oily ſubſtances, it is, alſo, deprived of its property of fulminating. It is the combination of the

xygen from the oxyde of gold with the hydrogen of the mmoniac, which produces the fulmination of this mixure of the oxyde and the alkali.

13. Gallic Acid.

The ſolution of gold affords by the *Gallic Acid*, a rediſh precipitate which is eaſily ſoluble in nitric acid, and ommunicates to this ſolvent a beautiful blue colour. lkaline *ſulphures* afford alſo a precipitate from the ſoluion of gold. Lead, iron, copper, ſilver, biſmuth, mercury, inc, and tin, having, all, a ſtronger attraction than gold r the acid, precipitate this metal from its muriatic ſoluons. Tin precipitates the gold in a powder known by he name of the *Purple Powder of Caſſius*, which is much ſed in manufactures of porcelain. *Ether* precipitates old from its ſolutions, in a metallic form.

14. Alloys of Gold.

Gold is ſuſceptible of alloy or combination with moſt f the other metals. *Arſenic*, *biſmuth*, *nickel*, and *antiony*, by their union with gold, produce a white and brite mixture. *Tin* and *lead* deprive the gold which they loy, of its ductility. The alloy of *iron* with gold is very rd, and fitter than gold itſelf for uſe in the Arts. *Copper* reaſes the fuſibility of gold, and renders its colour redder n before. The alloy of gold with *zinc* is a white and ttle mixture which has been thought very ſuitable as a terial for the mirrors of teleſcopes, becauſe it is not ſubt to tarniſh. Gold unites, in every proportion, with rcury. The amalgam thus formed, is darker in colour, more ſolid, in proportion as the quantity of the gold eater. It liquefies by heat; and by cooling, cryſtallizes minute quadrangular priſms. The alloy of gold with er is very pale.

15. Oxydes of Gold.

t is eaſy to perceive, that gold derives much of that ich renders it precious, from its averſion to any ready union [illegible] In moſt of its re-actions with acids, [illegible] appears to be at leaſt partially OXYDATED. [illegible] ſeems to be never pure from an intermix-[illegible] of gold: And even pure metallic gold is, like-[illegible], more or leſs, in all the neutral combina-[illegible]—or, at leaſt almoſt all.

[illegible] of great uſe in the Arts. *Gilding*, one of the [illegible] artificial applications of it, is performed in [illegible] different manners.—Leaves of gold are ap-[illegible] wood by means of ſome glutinous ſubſtance. [illegible] of gold-leaf are triturated to a paſte with honey; [illegible] waſhed with water; and dried for uſe in a [illegible] In *ſhell-gold*, this laſt preparation is mixed with a [illegible] matter, *Gold in rags*—is prepared by ſteeping [illegible] linen in the ſolution of gold, drying, then burning [illegible] by dipping a wet cork in the aſhes, and rub-[illegible] any ſilver-ſurface, which is thus eaſily gilded. [illegible] to that which is called *Water-gilding*, the cop-[illegible] gilt is, firſt, well cleaned, with ſand and diluted [illegible]; then plunged into a diluted ſolution of mer-[illegible] ſpread with gold over the mercury; then co-[illegible] with gilder's wax to prevent the gold from being [illegible] away while the mercury ſhall be volatilized by [illegible] The heating of the piece upon charcoal to drive off [illegible] mercury, and the burning away of the wax by a ſub-[illegible] heating, conclude the proceſs.——Gold is uſed for [illegible] &c. &c. It was anciently employed in me-[illegible] The apothecaries made their patients ſupply the gold; [illegible], that the purer the gold, ſo much the ſpeedier [illegible] be the cure. But, theſe ancient errors in favour of [illegible] medicinal virtues of this metal, have been, long ſince, [illegible] exploded.

SECTI

SECTION SEVENTEENTH.

PLATINA.

BOOK VII. Sec. XVII.

1. Diſcovery of Platina.

TINA was unknown in Europe, before the year Don Antonio Ulloa, then, gave the firſt informa-cerning its exiſtence, in the narrative of his voyage the French Academicians to Peru. Mr. Charles brought ſome ſpecimens of Platina to England, his return from the Weſt Indies; and, in the Philo-al Tranſactions for the years 1749-50, gave an of experiments which he had made to aſ-the peculiar nature of this metal. The moſt chemiſts in Europe have ſince examined it.

2. Native ſituations in which it is found.

found in Nature, only in a metallic ſtate. It ex-erally in maſſes or grains, and in combination with The largeſt native maſs of which we have heard, is the ſize of a pigeon's egg, in the poſſeſſion of the Society of Bergara. It occurs among alluvial ores ld, in the pariſhes of NOVITA and CITARIA, from CHOCO in Peru. It is conſiderably abun-and in the winter 1798-1799, a number of bars of etal have been offered for ſale in London. The Spa-overnment once prohibited it from being wrought, ſuſpicion that it might be employed, as an alloy

3. Different modes of purifying the ores of Platina.

perfect purification of PLATINA for uſe, is not to be accompliſhed. It has been wrought with the er, even in its native ſtate. M. ACHARD publiſhed in the year 1774, or about that time, a proceſs for its fuſion which is conſiderably ſimple. He put equal portions of platina, white oxyde of arſenic, and tartarite of potaſh into a well-luted crucible: An hour's expoſure of this mixture to a violent heat, afforded the platina in fuſion: The maſs, when cool, was whiter and more brittle than common platina: Expoſed anew to a conſiderable heat under a muffle, it gave the platina, perfectly pure, in conſequence of the evaporation of the arſenic.

M. de MORVEAU G[illegible]TON, inſtead of arſenic, as in the above proceſs, uſed [illegible]ſeniate of potaſh. He found, likewiſe, that platina w[illegible] fuſible by means of a flux of pounded glaſs, borax, a[illegible] charcoal.

PLATINA was fuſed [illegible] M. PELLETIER, in mixture with phoſphoric glaſs and charcoal. A phoſphure of platina, was thus formed; from which the platina was volatilized by heat.

BAUME' adviſes—the uſe of a ſlight addition of lead, antimony, biſmuth, or arſenic, to make platina come into a ſtate of fuſion; and the holding of the alloy in the fire, till the baſer metal ſhall have been diſſipated.

PLATINA may, indeed, be fuſed with any other metal ſuſceptible of ſolution in acids. The mixture muſt then be pulverized, and the acid applied to carry away the baſer metal. The pure platina may then be fuſed into a maſs, with Guyton's flux.——Inſtead of a ſoluble, an oxydable, metal may be employed, and treated as before.

4. Mr. Jannetty's proceſs.

The following is the proceſs of JANNETTY, approved by KIRWAN, as the beſt that has hitherto been uſed to purify platina.

Triturate common platina with water, to waſh off every contaminating matter that water c

Mix the platina with about one-fifth part of oxyde of arſenic and one-fifteenth part of pure potaſh; putting the whole into a proper crucible,—in the following manner. Having well heated the crucible and the furnace receiving it, put in one-third of the mixture: After applying to this, a ſtrong heat, add one-third more: After a renewed application of heat, throw in the laſt portion. After a thorough fuſion of the whole, cool and break the maſs. Then fuſe it a ſecond time, and, if neceſſary, even a third time, till it ſhall ceaſe to be magnetic. Then breaking it into ſmall pieces, melt thoſe pieces in ſeparate crucibles, and in portions of a pound and a half of the platina to each crucible, with an equal portion of arſenic and half a pound of potaſh.—After cooling the contents of the different crucibles in a horizontal poſition, in order to have them throughout of equal thickneſs,—heat them under a muffle to the commencement of evaporation, and maintain them in this ſtate, without increaſe of heat, for the ſpace of ſix hours. Heat them, next, in common [illegible], till the oil ſhall have evaporated to dryneſs.—Then immerſe them in Nitric Acid, boil them in water, heat them to redneſs in a crucible, hammer them into a denſe maſs. They are now fit to be heated in naked fire, and hammered into bars for the purpoſes of commerce.

5. Characters of pure Platina.

Platina, thus purified from all extraneous mixture, is of a white colour intermediate between that of ſilver and that of tin. It is the weightieſt of all metals; its ſpecific gravity being from 20,6 to 23. It is hard, malleable, ductile, laminable like gold. A cubic foot of platina, purified and forged, weighs 1423 pounds, 8 ounces, [illegible] drachms, 17 grains, old French weight.

6.
Action of Air, &c. on Platina.

From the action of *Air*, it ſuffers no alteration. Neither water, earth, the alkalis, nor the ſalino-terrene ſubſtances have any power of reaction upon it, in its ſolitary ſtate.

7.
Of Acids.

Of the Acids, only the *Nitro-muriatic* or the *Oxy-muriatic* act upon it. Both potaſh and ſoda precipitate it from this acid combination. The combination itſelf, when ſaturated, is of a dark-red colour. One part of platina contaminated with iron, being mixed with two parts of nitrate of potaſh, and in this mixture, expoſed for ſeventy-two hours to a conſiderable heat,—and then diffuſed in water,—gave an oxyde of iron,—with a ſmall portion of oxyde of platina.

8.
Heat.

Though nearly infuſible in the *fires* of our furnaces, PLATINA has been found to yield, even alone, to the heat excited by a continued current of pure air, and to that of powerful burning-glaſſes.

9.
Alloy of Arſenic with Platina.

The union of *arſenic* with PLATINA, by which the fuſibility of the latter is ſo much improved, was firſt attempted by Scheffer.

Biſmuth with Platina.

Its alloy with *biſmuth*, is a brittle maſs, not eaſily cupellable, and giving by cupellation, a maſs that has little ductility.

10.
Antimony with Platina.

By union with *antimony* its fuſibility is increaſed; and its weight and ductility are diminiſhed.

11.
Zinc with Platina.

It forms with *zinc*, a hard, fuſible alloy, from which the zinc may be in part, but ſeldom entirely, volatilized by fire.

12.
Tin with Platina.

PLATINA enters eaſily into union with *tin*. The alloy is very fuſible, very brittle,—when the tin is a large proportion, conſiderably ductile, of a coarſe grain, and liable to become yellow in expoſure to the air.

13. Lead with Platina.

The combination of *lead* with PLATINA is eaſily formed; is not ductile; is not cupellable; is not, in any manner, eaſy to be diſſolved.

14. Iron with Platina.

It has been found impoſſible to unite forged *iron* with PLATINA. But, from the fuſion of crude iron with this metal, there reſulted an alloy harder than that it could be acted upon by the file; ductile while cold; but, when heated, eager and brittle.

15. Copper with Platina.

An alloy of three or four parts of *copper* with one part of PLATINA, is ductile, ſuſceptible of a fine poliſh, not liable to tarniſh for a courſe of ten years.

16. Silver with Platina.

Silver in union with PLATINA, becomes harder, leſs ductile, of a more obſcure colour. The two metals are again ſeparable by fuſion and reſt.

17. Gold with Platina.

The utmoſt intenſity of heat is required to effect a combination of PLATINA with *gold*. The alloy is conſiderably ductile; but the original colour of the gold is entirely loſt.

18. Uſes of Platina.

This metal is adapted for many important uſes in the Arts. Its infuſibility and inalterability; properties which it poſſeſſes, though not abſolutely, yet in a higher degree than other metals; render it a very proper material for the compoſition of chemical veſſels. It is preferable to gold or ſilver, for theſe uſes, becauſe it may be welded or ſoldered, without mixture. Its denſity and opacity fit it admirably for the conſtruction of optical inſtruments,—as the Abbé Rochon has ſhewn in a mirror of platina which unites the advantages, without the imperfections, of thoſe of ſteel and thoſe of glaſs.

SECTION EIGHTEENTH.

URANITE.

OK VII
.XVIII

To the preceding metals, of which the knowledge [illegible] not at all new to the Chemical World,—are to be [illegible] ſome others of recent diſcovery.

1. res of ranite. One of theſe is URANITE, diſcovered by that very [illegible] German Chemiſt, KLAPROTH. It has been found [illegible] JOAHN-GEORGENSTADT in Saxony, in a maſſive, yellow ochre, which ſtains the fingers, and is infuſible to the blow-pipe. At the ſame place, it has been found in minute tables or cubes, or in ſix-ſided priſms of a graſs-green colour, or ſometimes, inclining to a ſilvery white. And in both theſe inſtances, it is mineralized by Oxygen. It is mineralized by ſulphur in the browniſh, greyiſh, and blueiſh black maſſes in which its ore has been found both at JOHAN-GEORGENSTADT in Saxony, and at JOACHIMSTAAL in Bohemia.

2. re Metal. Solutions in Acids, &c. gives from theſe, a pure metallic ſubſtance; of an iron-grey colour; conſiderable hardneſs; 6,440 of ſpecific gravity; in ſmall globules imperfectly agglutinated: ſomewhat leſs fuſible than manganeſe; by the blow-pipe, infuſible,—but with the addition of microcoſmic ſalt or concrete phoſphoric acid, convertible into a graſs-green glaſs,—with ſoda or borax, only into a grey, opake, ſcoriaceous bead.

3. xyde. OXIDE OF URANITE is yellow-coloured. In acids, it is eaſily ſoluble. With diluted vitriolic Acid, it affords

yellow

cryſtals. With Acetic Acid, it gives yellow, qua-
lar cryſtals. With Phoſphoric Acid, it affords an
hous maſs not eaſily ſoluble. Its ſolution in the
and in the *nitro-muriatic acids*, is of a wine-yellow
, and affords greeniſh yellow cryſtals. The ſolutions
ſe two laſt acids, yield,—by ammoniacal ſulphure, a
iſh yellow precipitate,—by alkaline gallates, a cho-
brown precipitate,—by pruſſiate of potaſh, a brown-
d precipitate, granular, and diffuſed through the
liquor,—by carbonates of potaſh and ſoda, precipi-
of a whitiſh yellow colour,—by ammoniac, yellow
itates. Neither Iron nor Zinc gives a precipitate
he Nitric or the Nitro-muriatic ſolution of OXYDE
RANITE. This Oxyde is abſolutely inſoluble in the
s.

SECTION NINETEENTH.

SYLVANITE.

1. Origin of Sylvanite.

KIRWAN gives this name to a new metallic ſubſt from Tranſylvania, which is diſtinguiſhed by peculiar remarkable properties. It has been very particularly mined by Mr. Muller.

2. Its Characters.

It is of a dark-grey or reddiſh white colour. found imbedded or diſperſed in grains. It has a faint, tallic luſtre. Its ſpecific gravity is 5,73;—but is creaſed by repeated fuſion, to 6,343. It melts as e as Lead, gives a thick white ſmoke, and kindles at laſt a browniſh flame. Its ſurface is fretted, as it cools, incipient cryſtallizations. By continued heat, it ev rates, at laſt, entirely away. It depoſites on charco thin layer of grey powder. With nitrate of potaſſ detonates, leaving an oxyde ſoluble in Acids, and fuſ by the blow-pipe, into a pearl-coloured glaſs. With cury, it eaſily amalgammates by ſimple trituration. combination with ſulphur, affords a ſtriated maſs. cold, or a low, digeſting heat, it gives, in concent ſulphuric acid, a partial and ſlight ſolution of a crim red colour. It is diſſolved, in a very moderate de with heat and effervefcence, in Nitric Acid: The tion, till heated, remains of a greeniſh colour. A ture of four parts of Nitric Acid with one part of trate of Ammoniac, gives a yellow ſolution of this

BOOK VII
SECT. XIX

e. In muriatic acid, it is inſoluble. Its oxyde
; to be more properly an acid, capable of com-
g with alkalis, though ſoluble, alſo, in other acids.
often alloyed with ſmall proportions of arſenic,
l, and gold.

SECTION

SECTION TWENTIETH.

MENACHANITE.

1. Origin of Menachanite. MR. MACGREGOR, not many years ſince, diſcovered what was found to be a peculiar metallic ore, in the vale of MENACHAN in Cornwall. It has been called, from the name of the place in which it was found—MENACHANITE.

2. Its metallic Characters. Its colour, in the metallic ſtate, is black. It is found in ſmall grains reſembling gunpowder, of no determinate ſhape, and often mixed with a fine grey ſand of great ſubtility. Its ſpecific gravity is 4,427; its powder is magnetic: and it is eaſily pulverized. It does not decrepitate by the blow pipe, and is not eaſily affected by microcoſmic ſalt. But, borax quickly diſſolves it, and makes it to aſſume a greeniſh colour. In great intenſity of heat, it acquires a ſlight increaſe of weight. With two parts of potaſh or ſoda, it melts into an olive-coloured maſs. From that maſs, nitric acid precipitates a peculiar oxyde. By particular management, this oxyde is ſoluble in acids. It is, by this ſolution, found to conſiſt of ,46 of Iron ſlightly oxygenated, with ,45 parts OXIDE OF MENACHANITE, a little ſilice, and perhaps ſome taint of manganeſe.

3, Its Oxyde. MENACHANITE, finely pulverized, mixed with concentrated *Sulphuric Acid*, and heated to dryneſs, aſſumes a blue colour. The addition of water to the blue maſs, alters the colour to a yellow; and the agitation of the liquor then gives a yellow ſolution. This operation is repeated, till the entire ſeparation of the iron, I

nger ſubject to be diſcoloured.—A white OXYDE OF
ACHANITE perfectly pure, yet remains at the bot-
Again expoſed to fire, this oxyde becomes of a
niſh red colour. It is now perfectly ſoluble in ſul-
ic acid. The ſolution depoſites a conſiderable pro-
on of white oxyde, by a boiling heat. It is preci-
le by fixed alkali. The frequent action of *Nitric*
on finely powdered Menachanite, renders the ferru-
us part ſoluble in water; and gives a reddiſh brown
pitate. Muriatic acid alſo takes up the ferruginous
er. The OXYDE is fuſible by borax, ſoluble by muriatic
nitric acids, more copiouſly ſoluble by ſulphuric acid,
ſubject to the reaction of Oxymuriatic or Nitro-mu-
acid, uncombinable with ſulphur or with fixed al-
Pruſſiate of potaſh gives a deep-green precipitate
its ſulphuric ſolution; gallate of potaſh, an orange
pitate; carbonate of potaſh or ſoda, a white precipi-
—The addition of a proper flux might probably
e this pure OXYDE to the metallic form.

SECTION

Titanite, and its Compounds.

SECTION TWENTY-FIRST.

TITANITE.

BOOK VII. SECT. XXI.
1.
Origin of Titanite.

AT RHONITZ, according to Baron BORN; according to others, at BOINICK, in Hungary; is found a peculiar ſubſtance, which was formerly called *Red Shorl*, but which the indefatigable KLAPROTH has lately diſcovered to be of a metallic nature.

2.
Its character.

It occurs in right-angled, quadrangular priſms, longitudinally ſtreaked or furrowed, nearly half an inch in length, often circular, depoſited between layers of ſchiſtoſe mica and quartz. It is opake, of an imperfect luſtre, of a foliated, uneven, conchoidal fracture. In powder, its colour is of a brick or orange red. It is hard and brittle. Its ſpecific gravity is 4,18. In a clay crucible, it remains unaltered by the heat of a porcelain furnace; and only becomes ſomewhat browner in colour. In a coal crucible, by the ſame heat; it burſts into angular fragments, loſes its luſtre and colour, and becomes pale brown. With borax, it melts into a hyacinth-coloured bead; with ſoda, into a whitiſh red bead. 200 grains of this mineral, with 5 times the weight of carbonate of potaſh, being melted in a porcelain crucible, formed, when cold, a denſe greyiſh white maſh, the ſurface of which exhibited acicular cryſtals; and its fracture was fibrous. By ſolution in boiling water, it yields a white precipitate, which, when edulcorated and gently dried, was found to weigh 328 grains, and to preſent the appearance o is is the TITANITIC OXYDE. The alkaline liquid natant, being afterwards ſaturated with Muriatic d, afforded an Argillo-Siliceous mixture of about 8 ns,—which might be from the crucible.

3.
Its Oxyde.

The OXYDE OF TITANITE is ſoluble in the Sulphu- the Nitric, and the Muriatic Acids. In the Nitric tion alone does it exhibit cryſtals by ſpontaneous eva- tion. The Sulphuric and the Muriatic Solutions of Oxyde form only a clammy maſs; which KLAP- aſcribes to the preſence of ſiliceous earth. Am- nc, pure, precipitates from theſe ſolutions, the Oxyde, ght, white woolly flakes. Carbonate of potaſh pro- s from them, a ſimilar precipitate. Their precipi- by pruſſiate of potaſh, is of a browniſh green colour. precipitate by gallate of potaſh, is of a browniſh red ur. Tin gives a blueiſh red colour to the Muriatic tion; Zinc gives it an indigo blue colour,—and with , a white precipitate. It ſhould ſeem, that *Red* is the ine metallic colour of Titanite.—This OXYDE is reducible by any of the uſual methods.—

A Calcareo-ſiliceous Ore of TITANITE has been nd near Paſſau in Hungary.

SECTION.

SECTION TWENTY-SECOND.

GENERAL REFLECTIONS ON THE METALS.

BOOK VIII. Sec. XXII

1. Malleability and Metallic Luſtre.

I. THE firſt thing that particularly ſuggeſts itſelf to
conſidering the general character and reſemblances o
foregoing metals—is—their being diſtinguiſhed by
leability and *metallic luſtre*, from the other *ſolid* and *f*
bodies among which th y are intermingled. The e
and alkalis differ from he metals, chiefly by the wa
theſe two qualities. the metals, the force of coh
is ſtronger and more tenacious than in other ſubſta
Thoſe ſtones which are the moſt refractorily hard
often found to poſſeſs metallic matters in their com
tion. *Malleability* implies a coheſion of parts ſtr
than that of mere, brittle hardneſs. The metals a
means of this quality, the principal agents in all m
mechanical combinations on the face of the globe.
metallic brilliancy diſtinguiſhes them eminently a
other ſubſtances. But for them, light could not w
reflected.

2. Diffuſion.

II. The next things which ſeem to deſerve our
cular regard, concerning metals in general,—are
univerſality, and the various modes, of their diff
They are ſcattered throughout every region of the h
able earth. Their proper ſituations may be in vei
its bowels. But, they appear, alſo, irregularly diſp
near its ſurface. They intermingle themſelves in the
poſition of all other foſſils. They enter

tion of vegetables. Even from the ſtrawberry, *iron* as been extracted. Gold is obtained from vegetable ſhes. They mingle with the nutriment of animals. Notwithſtanding their coheſive tenacity; they are ſuſceptible of an alteration and comminution, in which they may be ſuſpended in water, and even in air. Iron in particular, enters into all things, as a principle of coheſion, and of energy. If metals form the ſmalleſt part of the ſolid matters at the ſurface of the earth; they are, however, diffuſed in the greateſt diverſity of modes.

3. Metallic or Oxydated.

III. They are, all, remarkable, as exiſting, particularly, in two different ſtates. They either appear in a perfect *metallic form* or in the combination of *Oxydes*. Thoſe are the moſt precious, and the rareſt, which the moſt tenaciouſly retain their metallic properties. Of thoſe which are the eaſieſt oxydable, ſome, ſuch as iron, *lead*, and mercury, are very extenſively diffuſed throughout Nature. Metallic ſubſtances in general, appear, naturally, in a greater proportion, as oxydes, than in the true metallic form. It is in the form of *oxydes* that they become the moſt uſeful as colouring ſubſtances and as medicines, as well as enter into all their more intimate combinations with other bodies. As *metals*, they are much more averſe from the intimacy of chemical combination. They mingle, contaminate, aſſociate, in their metallic form, much more readily than combine. They are, for the greater part, averſe to an intimate union with acids, unleſs when they are previouſly oxydated. Some of them are even oxydable to ſuch a degree, as to become abſolutely acids, in their higheſt ſtate of oxydation.

IV.

4. Colouring quality. IV. Another property of metals deſerves more particular attention than it has hitherto obtained. This is their remarkable power of acting as colouring matters. It depends in a very conſiderable degree, on the ſimplicity and the *fixity* of their nature. They are not to be decompoſed; they do not aſſume the evaneſcent form of elaſtic fluids. It depends, alſo, upon their adheſive tenacity. Where you fix their particles,—there, theſe particles tend to remain. It is, however, chiefly as oxyds that they become colouring matters: For, they cannot, in their metallic form, be ſufficiently attenuated, nor be brought, ſufficiently, into artificial union with the ſubſtances to be coloured. Oxygen aſſimilates them ſomewhat more to thoſe gaſifiable bodies from which their natural ſolidity ſo remarkably diſtinguiſhes them. *What are their relations to light?*

5. Specific Gravity. V. Their ſpecific gravities are highly worthy of attention. They are the denſeſt and heavieſt of bodies. Being leſs under the influence of the attractions of chemiſtry than moſt other bodies; they ſeem, however, to feel, more powerfully, the influence of mechanical and aggregative attraction or gravitation.

6. Alliance with Sulphur. VI. Their ready alliance with *ſulphur* is one of their moſt remarkable qualities. In almoſt every aſſemblage of minerals, one or more of the metals are mineralized by ſulphur. This grand agent in the mineral kingdom, combines alike with metals, with alkalis, with earths,—if we take both the ſimple, combuſtible ſubſtance and its acid into our account.

7. Utility. VII. Their utility to human life, is highly remarkable. Medicine, painting, dyeing derive from them, their moſt

valuable

aluable materials. The mechanic Arts cannot exiſt without them. Strip our houſes of the metallic parts of their ornament and furniture,—how little beauty or utility would remain? What tonic remedy is comparable to iron, n whatever form it be adminiſtered? Is it not remarkable, hat iron, the moſt ſalutary to the animal œconomy, and he moſt uſeful in the Arts, of all the metals,—ſhould be he moſt abundant, and that which the moſt eaſily aſſumes great variety of forms and combinations?

8. Intimate Nature.

VIII. When Chemiſtry ſhall have been farther improved; is it not probable, that all the different ſimple meals may be reduced to a ſingle, metallic principle?

END OF THE SEVENTH BOOK.

ELEMENTS OF CHEMISTRY.

BOOK EIGHTH.

OF SOME REMARKABLE COMPOUNDS, WHICH, HAVING BEEN FORMERLY CONSIDERED AS SIMPLE, CAN BE LESS CONVENIENTLY DESCRIBED UNDER THE HEADS OF THEIR RESPECTIVE COMPONENT PRINCIPLES, THAN IN SEPARATE ARTICLES.

SECTION FIRST.

OF DIAMOND.

Book VIII
Sect. I.

1. Diamond not a peculiar ſubſtance.

Diamond is one of a number of ſubſtances, which, **ough** not ſimple, or at leaſt not *peculiar*, it has appeared **oſt** convenient, to introduce; in violation of the general **inciple** of arrangement in this work, as the ſubjects of **many** diſtinct articles.

2. Different from metallic Ores.

Diamond is not, like the metals, diffuſed in ores ſuſ-**eptible** of being purified, wrought, and put into new **mbinations** for uſe, by the operations of Art. It is **und** in Nature, pure, and in the only ſtate in which it **be** applied to human purpoſes.

3. Its peculiar characters.

It is the moſt tranſparent of minerals; ſo remarkably **hardeſt** of all bodies *, as to be incapable of being cut

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* Except, perhaps, Adamantine Spar.

by any other means, ſave the friction of one diar
againſt another; ſo refringent of light, and ſo capab
decompoſing it, that from this quality alone, New
conjectured it to be highly combuſtible; naturally exi
in octohœdral, duodecahœdral, &c. cryſtallizations;
cible to vapour, by a combuſtion, in which it burns
a perceptible flame. There is, in different diamonds, a
ſiderable diverſification of theſe qualities.

4. Places where it is found, &c.

The kingdoms of Golconda and Viſapour in the
and the Portugueſe poſſeſſions of Brazil in South Am
are the only regions known to afford DIAMONDS.
Portugueſe or Brazilian, are, in commercial eſtim
inferior to the Oriental DIAMONDS. They are f
ſometimes in the beds of rivers; but, moſt uſually,
ochraceous earth, under rocks of gritſtone and q
When taken out of the mine, they are incruſted wit
exterior, earthy covering, and under it, with another w
is of the ſame nature as calcareous ſpar. Theſe
MONDS, though commonly in cryſtalized forms, di
ſometimes, greater irregularity of ſhape, and are o
onally, either flat or round. They appear to con
laminæ diſpoſed one over another. They are eaſily
with an inſtrument of well-tempered ſteel. Some
MONDS diſplay rather the ſtructure of interwoven f
And theſe exceed the others, greatly, in hardneſs.
cannot be cut and poliſhed; and are, therefore, calle
the Lapidaries, NATURAL DIAMONDS. It is th
fringent power of the DIAMOND, which makes
ſplendid an ornament in dreſs. So ſtrongly is light ref
between its laminæ, that, when its ſides are multipli
cutting, each ſide or facet, exhibits a ſhe
rays. The ſpecific gravity of the pure,

f water, as 35,212 to 10.000. A cubic foot of PITT DIAMOND, would weigh two hundred x pounds, ſeven ounces, five drachms, and ſixty- , French weight. A great quantity of diamonds, at different times, imported into Europe. In the a ſuppoſed, that they might be obtained in grea- es than at preſent, if the ſufficient working of OND mines, were not prohibited, in order to t diminution of their commercial value, which bundance of them might occaſion.

5. Attempted decompoſition of the Diamond.

y of attempts were long fruitleſsly made, to de- IAMOND, by combuſtion, or otherwiſe.

6. Boyle's obſervations on it.

diſcovered, that it was alterable, at leaſt to a ree, by fire; and that, when violently heated, it rid vapours.

7. Experiments in the Court of Vienna.

peror FRANCIS *the Firſt*, at great expence, di- s important experiments to be made on the com- of DIAMOND. DIAMONDS and rubies, to of ſix thouſand florins, were expoſed in cruci- e ſpace of four and twenty hours, to a ſtrong ry heat. The DIAMONDS diſappeared: the rubies a change. A repetition of theſe experiments d, that DIAMOND under the action of *Heat*, s to loſe its ſmoothneſs and ſplendour, to fall ſcales, and, at laſt, to diſappear, entirely, in

8. By the Duke of Tuſcany.

ommand of the Great Duke of Tuſcany, Meſſrs. and TARGIONI, in the year 1694, expoſed MONDS to the heat of Tſchirnhauſen's mirrour. MONDS, in a few minutes, diſappeared.

9. By the Pariſian Chemiſts.

y the Pariſian chemiſts, D'ARCET, Laraguais, voiſier, Mitouard, Macquer, &c. reſumed the

Book VIII Sect. I.

DIAMOND, as a ſubject of philoſophical experi There was a diſpute concerning the combuſtibility DIAMOND, between the jewellers and the chemiſts. jewellers, in their expoſure of DIAMONDS to intenſ for the purpoſe of rendering them colourleſs, had nev any by vaporous diſſipation. All chemical experien preſented the diamond as deſtructible by violent he jeweller riſked a DIAMOND for a new experiment it was volatilized. Another jeweller riſked three dia in a cement of pounded charcoal, filling the bowl o bacco-pipe, over which was an iron-plate luted with founder's ſand. On theſe DIAMONDS, the utm tenſity of heat, could effect no change. The gen ſults of the whole experiments which were, abo time, made by the French Chemiſts, evinced; th DIAMOND was certainly decompoſable by heat; during its combuſtion, it was dilated at the ſurfac ſwollen ſomewhat in the manner of bubbles, with t hibition of a blue lambent flame; that it was not; ever, combuſtible, more than any other body, with preſence of air which ſhould furniſh oxygen, to c with it; that the DIAMONDS of the jewellers, h caped combuſtion, becauſe their cements abſolu cluded the preſence of air.

10. By Mr. Tennant. On the 15th of December, 1796, *Smithſon* TEN Eſq. read before the Royal Society of London, a nious paper, in which he related; that in differen ments of the combuſtion of DIAMOND in cont nitre, and free from the preſſure of any other [illegible] matter; the DIAMOND had been conſumed, [illegible] product which could be attributed to it, was c

ID-GAS nearly anſwering in quantity to the quantity of DIAMOND burnt.

BOOK VIII. SECT. I.

II. By MORVEAU-GUYTON.

Mr. MORVEAU-GUYTON has, very recently, made a uch more complex ſeries of experiments on the DIA- OND, with a peculiar apparatus. His general reſults s that DIAMOND is Carbon in perfect purity; that rcoal is an oxyde of DIAMOND; that *plumbago* is an de of DIAMOND, containing iron; that in *Carbonic* id, the oxygenation of DIAMOND, is, at laſt completed acidity; that in ſteel, there are particles of cryſtallized bon, of the character of DIAMOND, which produce e luſtre it emits, when highly poliſhed.

SECTION SECOND.

BITUMENS.

Book VII. Sect. II.

1. Bitumens in general. HYDROGEN and CARBON, with a contamination of earth and other ſubſtances in ſmall proportions, enter together, into certain compounds known by the general name of BITTUMENS, of which the ultimate nature was long unknown. Being compoſed of unoxygenated principles, which have a much ſtronger tendency to combine with oxygen, that to remain in mutual union; they are, of courſe, highly combuſtible. Though more than ſuſpected to be of vegetable origin; they are always found in a fluid or a foſſil ſtate. The following are their principal ſpecies.

2. Naphtha. I. NAPHTHA, a ſubſtance which exſudes from the rocks and clays in Perſia and Sicily; and is found, alſo, in different parts of Italy. Its colour is a white, often yellowiſh. It is fluid and tranſparent, like water; of a keen and penetrating, though not a diſagreeable ſmell; unctuous to the finger; and of an inflammability which kindles at the approach of flame, and leaves, after burning with a light, lambent flame, little or no reſidue. Its ſpecific gravity is not more than ,708; being, when the NAPHTHA is in its utmoſt purity, about one-ſeventh leſs than that of rectified ſpirit of wine. It is not congealed at the temperature 0° of Fahrenheit's thermometer; it is thickened but not inflamed by concentrated nitric acid; it is inſoluble in ſpirit of wine: in diſtillation, it paſſes entirely, without change.—It ſeems to be, in its pureſt ſtate, a com-

pound of hydrogen and carbon ſolely: Its inſpiſſation by the nitric acid is probably owing to the attraction of a quantity of oxygen inſufficient for its combuſtion with ſame: In combuſtion its two principles are diſſolved by oxygenation, into water and carbonic-acid. There may, perhaps, be a formation of water in a ſmall proportion, when it comes into contact with *Nitric Acid.*

3. Petroleum.

II. Petroleum is a mineral oil found near volcanoes, in the vicinity of coal-mines, in ſprings, or floating on the ſurface of ſprings of water contiguous to volcanoes. Its ſmell is more diſagreeable than that of Naphtha: Its colour is reddiſh or yellowiſh: It is very imperfectly tranſparent. It is leſs fluid than naphtha, and leſs inflammable; Its ſpecific gravity is 0,8783. Diſtillation with clay, clears its colour. By inflammation, this ſubſtance affords a ſoot, and leaves a ſmall portion of carbonaceous reſidue. —Its component parts are probably hydrogen and carbon in perfect combination, together with an addition of carbonic acid, and perhaps alſo a portion of uncombined carbon, or a contamination of ſome earth.—It is contained, in ſmaller or greater quantities, in various ſtones, ſuch as the *Black Limeſtones of Seefield in Tyrol,*—the *Bituminous Shale,* &c. In Scotland, it is often to be obſerved on ſtagnant water in peat-bogs: And to theſe it communicates all the colours of the rainbow. It is found, likewiſe, in Germany, Hungary, Poland, Switzerland, and in the South of France.

4. Aſphaltes.

III. Asphaltes or Bitumen Judaicum is a ſubſtance of the ſame general character. It floats on the lake *Aſphaltites* of Judæa: Mr. *Pallas* found it in Springs on the banks of the river Sock in Pruſſia. It exiſts, in the greateſt abundance, in the iſland of Trinidad. The aſphaltes theſe, though commonly united, appear ſometimes ſeparate. By diſtillation, theſe parts, which ſeem to have the ſame component principles, yield an oil inſoluble in ſpirit of wine, with a carbonaceous reſidue.

V. MINERAL TAR,—MINERAL TALLOW,—MINERAL CAHOUTCHOU,—are different bituminous ſubſtances, not without the contamination and intermixture of other matters.

6. Mineral Tar.

MINERAL TAR is a petroleum altered by expoſure to the air. It is black or of a duſky red colour; glutinous, and of the conſiſtency of pitch; ſometimes of but a very faint ſmell, ſometimes ſtrongly and diſagreeably odorous. In the air, it becomes viſcid, and, as is ſaid, lighter. Its ſpecific gravity is 1,1. It is found at *Lamperſlock*, near Straſburgh, in mixture with ſand, from which heating in water eaſily detaches it. It is alſo to be met with in many other parts of Europe, Aſia, and America.

7. Mineral Tallow.

Mineral Tallow is a ſubſtance rarely found in Nature It was, firſt, diſcovered, in the year 1736, by ſome peaſants on the coaſt of Finland. It has been ſince met with on a certain lake in Sweden; and in the water of a fountain near Straſburgh. It is of the conſiſtency of tallow; white; greaſy to the touch; apt to ſtain paper, like tallow, with traces which are melted by the approach of flame. It burns with a blue flame, and much ſmoke; leaving a coaly reſidue. Its ſpecific gravity is 0,770, more than one-fifth part leſs than that of common tallow. It is brittle. It may perhaps contain azote or nitrogen, in combination with carbon, not without the preſence of hydrogen, and with a contamination of other matters.

8. Mineral Cahoutchou.

MINERAL CAHOUTCHOU is a matter that has been found near Caſtletown, in Derbyſhire. It is brown; externally ſoft, flexible, elaſtic; internally, in part, hard, brittle, and of a greeniſh yellow colour. It is thus compoſed of two different parts of diſtinct characters; and theſe tion of hydrogen in union with its carbon: And the water is formed by the oxygenation of the hydrogen.

3. Kilkenny Coal. II. KILKENNY-COAL is, in its nature, nearly allied to the *Native Mineral Carbon*, that has juſt been deſcribed. Its colour is black or violet; its luſtre, metallic; its fracture, foliated. It is conſiderably hard; and its ſpecific gravity is 1,526. When wholly ignited, and not ſooner, it burns—without flame or ſmoke. Its chemical analyſis proves it to contain 97,3 of carbon,—3,7 of earthy matter, without any intermixture of bitumen.

The *Culm* of Wales, the *ſhining black ſcales* of the earth of New South Wales, and the matter which is called *ſmut*, appear to be of a character nearly ſimilar.

4. Splent Coal. III. The Coal of Ayrſhire in Scotland, there called SPLENT-COAL. It is of a greyiſh black colour; of a fracture partly ſlaty, and in part, imperfectly conchoidal, brittle, and conſiderably hard. 100 parts of it were found, by an analyſis that does not ſeem to have been very accurate, to contain 47,6 of pure carbon, 31,6 of maltha, and 20,8 of earth or earth and metallic oxyde. There is certainly, alſo a contamination of ſulphur among its component parts. Cannel Coal. This has been called, alſo, SLATY CANNEL COAL.

Compact Cannel Coal. There is a COMPACT CANNEL COAL, not very diſſimilar in its character. It is black, hard, in ſpecific gravity from 1,232 to 1,273, apt to kindle without melting, and to burn with a large and bright, but not durable flame. Its compoſition is, for 100 parts, 75,2 of Carbon, 21,66 of maltha, 3,1 of argillaceous aſhes.

5. Newcastle Coal. IV. The common MINERAL COAL from WHITEHAVEN, NEWCASTLE, *Wiggan* and *Swanſea*, in England, from *Leitrim* in Ireland, from *Irwine*, *Dalkeith*,

uſferry in Scotland, contains uſually—*carbon* in the pro- on of from nearly *three* to nearly *four-fifths*,—*bitumen* e proportion of from ſomewhat more than *one* to *two* ,—and *earthy* matter or metallic *oxyde* in ſome trivial ortion. The coals of *Halles*, *Tudertino*, *Cortolla*, *Macinaia* in Italy, are of a compoſition nearly lar.

6. Stony Coal.

. There is alſo a *Mineral Coal* which conſiſts of a ble impregnation of *ſtony matter*, joined to ſmaller ortions of *carbon* and *bitumen*, than exiſt in other pit- . Of this ſort are,—the calcareous *coal of Alaies*, hich BUFFON relates, that it is often burnt for the of its lime ; the *Anthracolite* which afforded to *Sage*, ng and intenſe ignition, a reſidue of 35 per Cent. of particles ; the ſtony coal of Macinaia, and that of aio in Italy ; the *Gueſt-Coal* of the ſtrata in the vici- of Edinburgh.

Gueſt Coal.

7. Suturbrand.

I. There are, alſo, carbonaceous minerals, which bear, remarkably, the appearance of a vegetable origin. ch is the LIGNIFORM, CARBONATED WOOD of nd, of which the original name is *Suturbrand*. It is brown or blueiſh colour ; flattened in its figure ; of ven or fibrous fracture ; exhibiting all the organic ure of wood.—ſometimes not without bark and hes. It is, at times, interſected by veins of quartz. ns with a diſagreeable ſmell, and much more faintly common pit-coal. It affords, when burnt, 42 per of Carbon.

f a ſimilar vegetable origin, is a SCALY, or EARTHY mentioned in the Journal of *Rozier*, by FABRIONI, by KIRWAN. It is compoſed of lamellæ which, moiſt, are flexible, and in ſome degree elaſtic. Its r is brown, blackiſh, or red. It is unuſually hard ; though

though ſometimes of a looſe earthy conſiſtency, it burns with an offenſive ſmell; and moulders away, in expoſure to the air.

Bovey Coal; Piligno.

The Bovey Coal or the Pilfgno of the Italians, is alſo, of evident vegetable origin. It is, in its fracture, fibrous, lamellated, or even, ſometimes conchoidal, often in the whole ſlaty: It is of conſiderable hardneſs: Its ſpecific gravity is from 1,4 to 1,558: It burns with a faint, creeping, blueiſh flame, and an offenſive ſmell. Its fibrous ſtructure was diſcovered by its ebullition in diluted Nitric Acid. It contains, often, pyrites, with ſulphates of iron and alum. Its proportion of pure Carbon, is from 54 to 75 per Cent.

VII. Peat and Turf are alſo carbonaceous matters, of which the general character reſembles that of the ſubſtances above deſcribed.

8. Peat.

The name of Peat may be appropriated to denote that pure, combuſtible, black, earthy matter of the moraſſes of Scotland, Ireland, and other countries, which is cut or baked by the common people into parallelogrammatic pieces of larger or ſmaller ſize, to which they give the name of *Peats*. When dried, it is hard, black, light, ready to burn with the vivid flame and the ſtrong, agreeable heat of the beſt pit-coal. It leaves but an inconſiderable proportion of aſhes, conſiſting of iron, ſulphur, and argillaceous earth. It contains probably a large proportion of hydrogen in union with pure carbon, a ſmaller quantity of uncombined carbon, with a proportion of nitrate of potaſh, ſulphur, earth, and perhaps phoſphore. It has its origin, at leaſt in peat, from the decay of ligneous vegetables, which is, however, prevented from becoming total, by the hydro-carbonous compounds, acid and bituminous, which are formed, while it goes on. Gramineous

plants,

in their decay, are alſo, no doubt, capable of
ting to the formation of this matter; but not in
a proportion;—for containing leſs of carbon,
ligneous,—they ſuffer their water to eſcape more
by evaporation,—and conſequently cannot give
a quantity of hydrocarbonous product.

9.
Turf.

is another ſpecies of this ſubſtance, which may
d Turf. It is ſpongy and porous, light, eaſily
able, full of moraſs-plants of which the organi-
ſtill entire, and apt to afford by combuſtion, a
able quantity of ſulphurated aſhes. It is probable,
ſubſtance owes its formation, more to the hydro-
acids, than to the bituminous hydro-carbones;
bitumens may be the principal ingredients of the
t contains alſo carbon, ſulphur, and nitrate of
perhaps, alſo, phoſphore, certainly earth and iron.
e ſtrata of Peat and Turf, are often found
unks of trees, animal remains, and productions
n Art, in a ſtate of entire preſervation. Empy-
Acids are formed, during the combuſtion of Turf
T.

bitumen which has been deſcribed under the name
tha, exiſts, in a large proportion in ſeveral of
e ſpecies of Coals. It is obtained from them by
n. They afford, at the ſame time, gas-ammo-
his gas muſt ariſe, either—from the decompoſition
hydro-azot-carbonous compound in the coal, of
e preſence has not yet been detected,—from the
of ſome ſmall portion of nitrate of potaſh in
rom a new combination of the diſengaged hydro-
h the azote of the atmoſphere. The Earl of
nald's eſtabliſhments for the extraction of the

Maltha and *ammoniac* from pit-coals by diſtillation, have failed, only becauſe Artiſan-experience was wanted to make them more completely ſucceſsful. The Prince of Naſſau-Saarbruck, M. Sage, and M. Faujas St. Fond have alſo tried the ſame manufacture. The reſidue contains always ſulphureous ſalts.

SECTION

SECTION FOURTH.

SUBSTANCES IN WHICH THE BITUMIDOUS MATTER IS IN COMBINATION WITH AN ACID.

Book VIII
Sect. IV.

1.
Amber.

1. AMBER is a ſubſtance of a yellow colour, or ſome-imes brown; exiſting in irregular fragments of a ſcaly tructure; tranſparent or opake; in ſpecific gravity from 1,078 to 1,085; ſuſceptible of a fine poliſh; and poſſeſſ-ing an electric virtue, which it readily diſplays by friction; ard but brittle and friable, apt to diffuſe by pulverization, n agreeable ſmell; containing, occaſionally, in its maſſes, e bodies of inſects in a ſtate of preſervation.

It is found, at various depths, buried in the earth, under oured ſand, and on beds of pyritous earth, having ve it, wood which contains a black bituminous matter. loats, alſo, on the ſea-coaſt. It is found on the North- coaſts of Scotland, on the ſhores of the Baltic, in cal Pruſſia, in the hills of Provence near Siſteron, in Marquiſate of Ancona and the Duchy of Spoletto in ly, in Sicily, Poland, Sweden, and other countries. It ars under many diverſities of colour and form. But its eral appearance is ſuch as has been above deſcribed. at which is tranſparent and golden coloured, is valued moſt highly. The true origin of this ſubſtance has never been ſatisfactorily explained; nor has even any theory uſible as to deſerve our particular notice, been pro- concerning it.

2. Analyſis of Amber.

A conſiderable intenſity of *Heat* is requiſite to reduce AMBER into a ſtate of liquefaction.—While expoſed to heat, it becomes ſoft, ſwells, bubbles up, if in contact with air—is apt to take fire, burns with a yellowiſh flame—which is however variegated with green and red, leaves after its combuſtion, a ſparkling coal, the incineration of which gives a very ſmall quantity of brown earth. —The *diſtillation* of AMBER affords an acid phlegm, a volatile acid ſalt which cryſtallizes in the neck of the retort, and a reſidual black bituminous maſs of a brittle conſiſtency.

3. Its compoſition.

The reſult of the moſt accurate chemical analyſis of Amber has proved its acid to be that peculiar acid with a compound baſe, which has been deſcribed under the appellation of the SUCCINIC ACID.—Its remaining part is *oleaginous* or *bituminous*.

4. Its uſes.

AMBER, its Acid, and its oil are adminiſtered in various preparations, as a ſtimulative medicine. It is cut and poliſhed into toys, ſnuff-boxes, bracelets, necklaces, heads of canes, &c. Thoſe pieces of AMBER which are highly tranſparent, may be uſed for microſcopes, burning-glaſſes, priſms, &c. The late Frederic the Second, the great King of Pruſſia, is ſaid to have had an AMBER burning mirrour which was a foot in diameter. In the cabinet of the Grand Duke of Tuſcany, there is ſaid to be a column of Amber ten feet high, of a very brilliant and beautiful luſtre. Two pieces of AMBER, if dipped in a ſolution of potaſh, may then be permanently joined into one. Anciently, when diamonds and precious ſtones were more rare, AMBER was much more highly valued than at preſent.

II.

5. Jet.

II. Jet, a pure black ſubſtance, of conſiderable luſtre, but without tranſparency, is found in the county of Foix, and in Provence, at Beleſtat on the Pyrenees, in Sweden, in Germany, and in Ireland. Its quarries are in ſtrata; pyrites, pit-coal, and other bitumens are aſſociated with it. It is hard, brilliant and vitreous in its fracture, liable to be excited to electricity by friction, ſuſceptible of a fine poliſh. Its ſpecific gravity varies in different pieces; in one, it was 1,259; it is, in others, 1,744; and ſome ſpecimens float upon water. It burns with a greeniſh flame. May it not be bitumen in union with a very ſmall proportion of acid?

6. Ambergris, &c.

III. Ambergris and Copal are two ſubſtances, which, though not properly of mineral origin, yet greatly reſemble the modifications and combinations of the bitumens.

Ambergris is a grey or yellowiſh brown matter, with black ſpots. It is found in the inteſtines of ſpermaceti-whales in a ſtate of ſickneſs, or in ſmall rough lumps floating in the ſea. Its hardneſs and conſiſtency are the ſame as in wax; its fracture is earthy; and it generally contains bones of fiſhes, or beaks of birds. It is without taſte, but has, when heated, a ſtrong, agreeable ſmell. A gentle heat ſoftens it, as wax; but, by a ſtrong heat, it is inflamed; and it then burns away, if pure, without leaving a reſidue. Its diſtillation yields an acid phlegm, a volatile ſalt, an oil, and a black gliſtening reſidue; ſo that it may be regarded, as a ſort of bitumino-animal matter.

7. Copal.

Copal is a ſubſtance of a yellow colour, faintly gliſtening, imperfectly tranſparent, conſiderably hard and brittle, apt to break with a conchoidal fracture. Its ſpecific

cific gravity is from 1,04 to 1,062. It is taſteleſs, and while cold, inodorous. When heated, it burns with a yellow flame, a white ſmoke, an aromatic fragrance; leaving a carbonaceous reſiduum. It often contains inſects. It is of vegetable origin; and, as it ſhould ſeem, of an acido-bituminous character.

SECTION FIFTH.

HOSE PARTS WHICH, THOUGH THEMSELVES MPOUNDS, ARE CONSIDERED AS THE COMPO- NT PRINCIPLES OF VEGETABLES.

Book VIII. Sect. V.

Enumeration of the Immediate Principles of Vegetables.

VEGETABLE ſubſtances are compounds of calo- ght, water, air, earths, alkalis, and metallic matters. ie energies of vegetative life and organization ela- theſe elements into a ſpecies of compounds, which a conſiderable degree, ſimple in their form, and in- in the union of their component parts, and which een denominated the IMMEDIATE PRINCIPLES GETABLES. Theſe are Extract, Mucilage, Sugar, al Salt, Fixed Oil, Volatile Oil, Aroma, Camphor, Balſam, Gum-Reſin, Feculum, Gluten, Colouring , Gum Elaſtic, The Ligneous Part.

1. Extract.

XTRACT is the firſt of theſe *immediate principles etables.* The *juices* of plants, obtained from them, chanical preſſure, by the ſimple infuſion of the a liquid, or by its decoction in boiling water; in- d; and at laſt evaporated to dryneſs; afford a dry, matter, ſlightly deliqueſcent in the air, and ſoluble r, which is the EXTRACT. This matter yields illation, an acid, a ſmall portion of ammoniac, ne oil. It abſorbs oxygen from the atmoſphere, omes gradually inſoluble, in conſequence of this ion. It has conſtantly a tendency to take up more firſt proportion of oxygen. Its component prin-

principles are carbon, hydrogen, azote, and oxygen. The juices of acacia and hypociſtis, opium, liquorice-juice, the cachou, &c. are EXTRACTS. Their preparation is not difficult, and may be managed, either in the great way, for the purpoſes of extenſive commerce, or in ſmaller trials.

30. Mucilage. II. MUCILAGE is another of theſe *Immediate Principles of Vegetables.* It is viſcid and inſipid. It affords, by diſtillation,—pyro-mucous acid,—a large proportion of water,—a ſmall portion of a brown, thick oil,—and a mixture of carbonic acid-gas with gas-hydrogen. It is ſoluble in water, whether hot or cold: it does not abſorb oxygen from the atmoſphere: deſiccation gives it the hard and brittle form of GUM. It exiſts in the roots, in the tender twigs, in the leaves—of plants. It is obtained by expreſſion, from the bark of trees. Their fibres are, during growth, connected by it. The roots of mallows, marſh-mallows, and comfrey, the bark of the elm-tree, the ſeeds of flax and of quinces, &c. afford, by maceration in water, viſcous fluids, which evaporation dries and hardens into the ſtate of *Gums.* The gums of the plum, the peach, and the cherry-tree; Gum-Arabic, Gum Senegal, Gum Adraganth, ſubſtances ſufficiently known in commerce, are, all, of this character and origin. Treated with *Nitric Acid*, mucilages and gums afford *oxalic* acid.

31 Sugar. III. SUGAR is well known, as an immediate principle of Vegetables. It is very extenſively diffuſed throughout the vegetable kingdom. It is commonly obtained by preſſure, and a ſubſequent proceſs of purification, from the *Arundo Saccharifera*, and by different proceſſes, from the juice of the maple-tree, and from the roots of the beet and the parſnip. It may be procured alſo from the petals,

and

the nectaria of divers flowers. In its pure ſtate, is of an agreeable poignant taſte, cryſtallizable, fermentible, and,—but for its ſuſceptibility of tion, and its capacity of affording, by a proper t, alcohol,—in other reſpects, very little diffen mucilage. It is a compound of carbon, with n, and oxygen. It differs from mucilage in cona ſmaller proportion of hydrogen, and in having ion of azote in its compoſition. It, therefore, attracts oxygen from the atmoſphere, nor yields iac by diſtillation. It is one of the moſt common of uſe and luxury. In its ordinary ſtate, it uſually by decompoſition, in the retort, a reſidual coal ontains a ſmall portion of carbonate of potaſh: action of the fire forms from its principles, durproceſs, a portion of pyro-mucous acid, and of ematic oil. The proceſſes for the preparation of the s *of commerce*, will be, hereafter, more particularly

4. Eſſential Salt.

ESSENTIAL SALT comprehends all thoſe vegetable hich have been already enumerated and deſcribed,— ic, the gallic, the malic, the benzoic, the tartareous, lic, the camphoric, the pyrotartareous, the pyro-, the pyroligneous, the acetic acids; ſo many nds which have for their baſes, hydrogen and united in various modifications, and joined to the l acidifier, oxygen. Theſe Acids are obtained, llation, from moſt other vegetable matters. They ompoſable by fire, mutually ſuſceptible of conver-o one another, and all reducible, in an ultimate , to water and carbonic acid. *Alkalis* are alſo ob-rom certain vegetables, as is well known, in particular

ticular circumſtances. Even neutral ſalts, formed by [illegible] combination of the alkalis with mineral acids, are obtai from a variety of vegetables.

5. Fixed Oil.

V. Fixed Oil is an *immediate principle* in the co poſition of many vegetables; and may be obtained ſep rate, from them. It is thick, mild, inodorous. It bur when reduced to volatilization. With the alkalis, it fo ſoaps. By the contact of air, and the abſorption of gen, it is thickened and concreted. Abſorbing oxyg alſo, from the acids and the metallic oxydes, it ſuf from them, the ſame changes. It is eaſily combuſti and, when burnt with a ſufficient quantity of air, te naturally to the production of water and carbonic a This laſt effect takes place, very remarkably, in holl matches made with oil, in which the match is acted up by an internal current of air, as well as by air environ it on all ſides. This oil is mixed with a mucilage wh Scheele has called the *Mild Principle of Oils*. Its co ſtituent elements are carbon, hydrogen, and a ſmall pro portion of oxygen. It differs from the preceding vegetables, as containing a larger proportion of oxygen. Theſe *Fixed Oils* are applied to a number of well known uſes in domeſtic œconomy. A heat more intenſe than that of boiling water is requiſite to volatilize them; and it is only after being heated to volatility, that they take fire and burn. —They never flow from the ſurfaces of vegetables; but are contained in the kernels, the pippins, and the emulſive ſeeds. They are extracted by pounding and ſqueezing. In the air, they become rancid, and, indeed, undergo a general change of properties.—By trituration with lime and ſoda, they afford a medicinal ſoap. They combine with the weak acids, to form peculiar ſoaps. The fuming

ouſly blackens theſe fixed oils, and Book VIII. Sect. V.
of them as are of a dry nature. The
carbonic acids act upon them with but
heſe oils diſſolve ſulphur, with the aſſiſt-
iling heat. Of the pure metallic ſubſtances,
binable only with iron and copper. With
xydes, however, they form thick, concrete
, of a ſoapy appearance. They diſſolve the
ubſtances,—particularly amber, with the aid
, by this ſolution, form a ſort of greaſy var-
es not readily become dry. The moſt re-
cies of theſe oils, are—*pure fixed oils* which
ation to the gradual influence of cold, ſuch
es, oil of ſweet almonds, oil of rape-ſeed,
ils not fixable by cold, ſuch as lintſeed oil,
il of carnations or poppy ſeed, oil of hemp
concreted vegetable oils which are called
ers, among which may be diſtinguiſhed—
s, extracted from the cocoa-nut, *butter of*
Chineſe production, *vegetable wax*.—In the
dicine, theſe *fixed oils* are applied to a great
rpoſes.

TILE OILS, named likewiſe *Eſſential Oils* 6. Volatile Oil
able of liquid fixity, in a ſeparate ſtate.
ſtrong aromatic ſmell; diſtillable by a boil-
acrid to the taſte; and much more com-
he *Fixed Oils*. They exiſt in almoſt all
. They are, in theſe, either diffuſed through-
plant, or only in the root, or confined to
n the leaves, in the flowers, in the rind of
n the ſeeds. In ſome plants, the *volatile oil*
in others, in larger quantity; This oil, in
different

different plants, varies in conſiſtency, in colour, in gravity, in taſte and ſmell. It is extracted, either by preſſure; in which caſe, it is called *Eſſence*, or by diſtillation. These oils are adulterated ſometimes by various fixed oils; which is indicated by their ſtaining paper,—often by oil of turpentine, eaſily detected by its ſtrong and peculiar ſmell. By moderate heat, *Volatile Oils* are deprived of their ſmell. In the air, they thicken, and are gradually converted into reſins. In this inſpiſſation, they are brought to depoſit cryſtals, like thoſe of ſublimated camphor, —as was obſerved by the younger Geoffrey, in regard to the volatile oils of mother-root, marjoram, and turpentine. They combine, though not very readily, with lime and alkalis; forming by the combination, thoſe ſubſtances which are named *Saponulæ*. With ſulphur, they form thoſe compounds which are called Balſams of Sulphur, and are decompoſable by heat, which makes them give out ſulphurated hydrogenous gas. They are rendered ſoluble in water by the addition of mucilage and ſugar. They are uſed in medicine, as ſtimulants, and as antiſeptics. Their decompoſition by combuſtion in air, or by heating in cloſe veſſels, proves theſe *Volatile Oils* to conſiſt of hydrogen and carbon, combined in peculiar modifications.

7. Aroma. VII. **Aroma** is another ſubſtance peculiar among thoſe which are called the *Immediate Principles of Vegetables*. It is plentifully diffuſed in the vegetable kingdom; though in ſome plants more abundantly, in others, more ſparingly, in ſome in a ſtate in which it is more fixed, in others, ſo as to be more fugitive. It is diſengaged from any plant by a very moderate heat. The uſual practical means of procuring it, is by diſtillation in a water-bath, from which

its

pours, being received in a cold capital, are there con-
d, and thence conducted, fluid, into the receiver.
product is a pure odoriferous water, known by the
of *Eſſential* or *Diſtilled* Water. This liquor is to
onſidered as a ſolution of the odorate principle in
r. By heat, it ſoon loſes its odour, and becomes
ctly inſipid.—The pure volatile Aroma is a ſub-
e of which the intimate nature is not perfectly known.
aps it may be a peculiar gas; perhaps only a parti-
gazeous modification of ſubſtances previouſly fami-
o the chemiſt. It is nearly allied to *Volatile Oils*, and
s to be always, in greater or ſmaller quantity, pre-
in them. It combines, alſo, with alcohol, fixed oils,
inegar. It is ſometimes, evidently of an inflammable
e. A ſeries of experiments, to aſcertain its intimate
e, is very much to be deſired.

8.
Camphor.

II. Camphor is an immediate *principle* of vege-
which is now known to exiſt in many different
It is a white, concrete, cryſtalline matter; of a
taſte and ſmell; highly volatile, combuſtible with
t, ſoluble in a large proportion of water, in alcohol,
ther. It exiſts in many volatile oils. It is moſt
only extracted from the leaves and wood of a ſpecies
rel, the native growth of China, Japan, the Iſles of
Sumatra, Ceylon, &c. It is obtained, too, from the
f the cinnamon-tree, from Zedoary, thyme, roſemary,
d many other labiated plants, either by diſtillation or
It is thought by chemiſts to be a principle in the
ion of all highly odorous plants which contain
oil. The oriental tree from which it is moſt
extracted, contains it in ſuch abundance, that the
ing of the wood, often gives it out in large
tears

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tears of great purity. The diſtillation of the roots or
parts of this tree, with water, in an alembic of iron,
vered with a capital containing ropes of rice ſtraw, af
the camphor ſublimated in ſmall greyiſh grains w
unite into larger pieces. This is crude camphor, whi
to be purified by ſublimation in a balloon, with the
tion of an ounce of lime for every pound of the
camphor. It cryſtallizes in hexagonal plates with a
in the middle. An ordinary ſummer heat is ſufficie
volatilize it. In expoſure to the air, it is entirel
and diſſipated. Its ſmell is ſtronger than to be endur
perſons whoſe nerves are very irritable: It is ſoluble
in a large proportion of water: It burns on the ſurfa
this fluid: ſmall pieces of camphor, when put into w
move round till they are diſſolved, with a ſort of m
ment, that ſeems to depend on electricity, and is
ſtopped only by touching the water with ſome
which may act, as an electrical conductor. Acids
concentrated, diſſolve camphor: the ſulphuric acid
ducing from it, with the aid of heat, a red ſolu
while the ſolution produced with the Nitric Acid, is
low. The *Camphoric Acid* already deſcribed, was
obtained by M. Koſengarten, in conſequence of the
lation of nitric acid upon camphor, for eight times
ceſſively. Muriatic acid gas, ſulphureous acid gas,
ric acid gas diſſolve camphor: but the infuſion of
into theſe ſolutions, ſeparates the camphor in f
Theſe ſolutions are alſo precipitated by alkalis and
terrene ſubſtances. Both the fixed and the volatil
diſſolve camphor: And theſe ſolutions afford by co
cryſtallizations in a vegetative form, ſimilar to thoſe
are produced from muriate of ammo

nown to be ſoluble, likewiſe in alcohol; and this
n affords, too, a ſort of vegetative cryſtallization.
or is uſed as a powerful ſtimulant and antiſeptic re-
n medicine. It is given in a triturated preparation
lks of eggs, ſugar, and gums, in oil of camphor, or,—
rnal applications to gangrenes,—in camphorated
f wine. Its intimate nature is not, indeed, very
arly known; but, it is without doubt, a combina-
hydrogen with carbon, in certain peculiar propor-

9. Reſin.

Resin is a vegetable matter, ſoft or dry, ſcarcely
, combuſtible, ſoluble in alcohol, but not in water;
r alterable by acids, hardly ſuſceptible of union
kalis; obtainable from an inſpiſſated volatile oil,
which it ſeems to differ—only in poſſeſſing a larger
tion of oxygen. The principal ſpecies of reſins,
following: *Balſam of Mecca*, Judæa, Egypt, or
Cairo; liquid, bitter, and of a high lemon-co-
dropping naturally from a tree named *Amyſis Opo-
ſum*, which was little to European Naturaliſts, till its
ry by M. Forſkahl, in Arabia Felix:—Brown or
balſam of Copahu, the produce of the tree called
a, or *Copaifera*:—*Turpentine of Chio* which runs
he turpentine-tree that bears piſtachio-nuts,—and
white or yellow colour inclining to blue: *Venetian
ſian turpentine*, which, either alone, or in union with
ali, is the moſt commonly uſed in medicine. The
f the fir-tree, obtained by piercing the veſiculæ of its
the foreſts of Switzerland, and known in commerce,
name of turpentine of Straſburgh:—*Pitch*, the juice
Abies Picea, procured by inciſion from the bark of
: *Galipot*, the reſin of that pine which bears ſoft ap-
ples,

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ples, obtained by notching the tree towards its ro
ſetting troughs to receive the reſin while it runs :–
mahaca, gum elemi, gum animæ, reſins which are b
known, and little uſed: *Maſtic*, a ſubſtance in wi
rinaceous tears, faintly odorate, which diſtils fr
turpentine tree, and is uſed in drying varniſhes,
aſtringent and aromatic;—*Sandarac* obtained fr
juniper-tree, in white tears, more tranſparent tha
of maſtic,—and uſed in powder, to prevent in
ſinking into paper from which the exterior coa
ſize, has been ſcraped away: The greeniſh *reſin o*
acum obtained by inciſion from the tree of th
name: *Labdanum*, a blackiſh ſubſtance, the reſi
ſpecies of ciſtus which grows in Candia: *Dragon's*
extracted from the *Dracæna Draco* and ſome oth
of a kindred nature. All theſe reſins are compo
oxygen, ſuperadded to a previous, oleaginous comp
hydrogen and *carbon*. They are applied to divers
Medicine and in the Arts.

Balſams

X. The Chemiſts diſtinguiſh by the name of Ba
a few ſubſtances, *immediate principles of Vegeta*
which reſin appears to be united with Benzoic
Benzoin, a matter in white tears which is impor
Europe from the kingdom of Siam, and the iſland
matra, is of this character. Such, alſo, is the *Ba*
Tolu, *Peru*, and *Carthagena*, which flows from th
Toluifera, and is brought to Europe, in cocoa-nutſh
yellowiſh tears, or in fluid ſtate. The *Storax Ca*
a product of the oriental plant *Liquidamber*, whic
formerly imported into Europe in reeds, but now
uſually, in loaves or irregular maſſes of a reddiſh
colour, with a few tears intermixed,

nore pleaſant ſmell,—is another ſimilar balſam.
enzoic acid, one of the component parts of theſe
the nature has been already explained. Their
nciples are hydrogen, carbon, and oxygen.

11. Gum-Reſin.

UM-RESIN is a concrete, vegetable juice, imper-
luble in water. With water, and with vinegar, it
ort of emulſion. In alcohol, it ſtill is more ſoluble.
ot flow naturally, like Reſin, from vegetables :
to be obtained by bruiſing their veſſels, out of
comes in a white or variouſly coloured juice, of a
our, more or leſs reſembling that of garlic. They
conſiſt of reſin mixed with *Extractive Matter*.
owing are the moſt important ſpecies ;—*Olibanum*
of yellow, tranſparent tears, of a ſtrong diſa-
ſmell ;—*Galbanum*, a fœtid juice of a brown yel-
our and a nauſeous ſmell, procured in Arabia, in
d at the Cape of Good Hope, from inciſions in
ous plant,—the *Bubon Galbanum* of Linnæus ;—
y, a ſubſtance of a blackiſh-grey colour, a ſtrong
ſmell, and a bitter and very acrid taſte, which
om Aleppo and Smyrna, and is extracted from the
ned by Linneus, *Convolvulus Scammonia* : *Gum-*
yellow, reddiſh matter, without odour, of a ſtrong,
roſive taſte ; which comes from Siam, China, and
of Ceylon ; and is there extracted from a large
ed *Coddam-Pulli* with which, however, we are
acquainted ;—*Euphorbium*, a matter in yellow
a carious appearance, and without ſmell ; ob-
inciſion from the plant *Euphorbium* in Abyſſinia,
nd Mauritania ; exceedingly acrid, and even dan-
purgative ;—*Aſſa-fœtida*, a ſubſtance in loaves or
tears ; of a fœtid ſmell, a bitter taſte, and in

the

the whole, nauſeouſly diſagreeable;—the produce of the root of a ferula of the province of Cheraman in Perſia, which Linnæus has named *Aſſa-fœtida*;—*Aloes*, a juice of a dark-red or brown colour; bitter to the taſte; obtained by inciſion, from the leaves of the aloes tree; and uſed in medicine, as a purgative remedy of great efficacy;—*Myrrh*, a matter in the form of tears, of a brilliant appearance, of a ſtrong but agreeable ſmell, bitter to the taſte, and in the fracture of the tears, exhibiting white lines of the form of a nail: It is obtained from Egypt and Arabia, und is uſed in medicine and ſurgery, as a ſtimulant remedy:—*Gum-ammoniac*, a ſubſtance which we get from Africa,—ſometimes in tears—internally, white,—externally, yellow, often in maſſes reſembling thoſe of benzoin: It is thought to be extracted from an umbelliferous plant.

12. Gum Elaſtic.

XII. GUM-ELASTIC appears to exiſt, as an immediate *principle*, in many vegetables; is remarkable for the ductility and elaſticity which it retains when dry; yields ammoniac by diſtillation; when burnt, diffuſes a fœtid odour; exiſts, at firſt, in the form of a white, lacteous fluid, and paſſes into the ſtate of Gum-elaſtic by abſorbing oxygen from the atmoſphere. It is known, alſo, by the name of *Caoutchouc*. It is extracted from a tree, the growth of various parts in America, by inciſions, penetrating through the bark, to the wood. The juice is, at its firſt flowing, white as milk, and inſufferably fœtid. Condenſed into thoſe bottles in which it is ſeen in this country, it is inalterable by water, ſubject to be diſcoloured by the action of alcohol aided by a boiling heat, decompoſable by ſtrongly concentrated nitric acid, ſoluble by volatile oils with the aſſiſtance of a gentle heat.—From the laborious conſiderably accurate, chemical analyſis of this ſubſtance, which was made by M. Berniard, it ſeems to conſiſt of hydrogen and carbon, with perhaps an addition of azote.

13.
Feculum.

XIII. Feculum exiſts in all white and brittle parts of Vegetables,—particularly in tuberculous roots, and in the grains of gramineous plants. It is a pulverulent, dry, white, inſipid, combuſtible matter. It yields by diſtillation, a large proportion of pyro-mucous acid ; is ſoluble in boiling water ; forms, with this liquid, a jelly ; is convertible by the nitric acid, into oxalic and malic acid ; forms the baſis of the nouriſhment of animals ; and becomes, with ſufficient readineſs, a principle in the living animal body. All the ſolid parts of vegetables, are, more or leſs, capable of affording fœculum. But, ſome yield it in a greater abundance ; and it is, therefore, prepared rather from theſe for the uſes of the Arts. The fœcula of wheat, potatoe, ſago, ſalop, briony, deſerve particular notice.

Potatoe.

The fœculum of POTATOE may be obtained ſeparate, by the eaſy proceſs of grating down the potatoes, and pouring upon the grated ſubſtance, a ſufficient abundance of water. The fluid takes up in ſuſpenſion, the fineſt portion of the attenuated fœculum ; and, after ſtanding for ſome time, again depoſites it. The water being now decanted off, and the fœculum at the bottom, dried ; this matter is obtained in the form of a fine light powder. It is commonly prepared by the peaſantry, in the more remote parts of this country, for ſtarch. It is made in the ſame way, by mills, in which the potatoes are grated down by a ſort of graters turning upon cylinders. One need ſcarcely obſerve, that *potatoes* become uſeful as an article

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of food, whether roaſted, boiled, in bread, or in pudding solely in conſequence of their containing fœculum in ſuf abundance.

Briony.

The *fœculum* of BRIONY is extracted and prepared fo medical uſes, by an eaſy proceſs. Take any quantity o freſh roots of this plant; ſtrip off the bark; raſp the roots to pieces; ſubject the raſped roots to the preſs: a white juice will be thus ſqueezed out, which will depoſit by ſtanding, a very fine fœculum. A quantity which ſti remains in this fœculum, but may be carried off by waſh-ing before it has become dry, renders it, if the waſhing have been neglected, very acrid, and violently purgative. The repeated dilution of the maſs remaining in the preſs, will afford a new quantity of fœculum, which is not purgative.

Caſſava.

From the root of a very acrid plant, named *Manioc*, the native Americans have, from time immemorial, extracted a very pleaſant and nouriſhing *fœculum*, to which they give the name of CASSAVA. They ſtrip the root of its bark, grate it down, put the grated matter into a ruſh-bag of a conical figure, and a very looſe texture then hang the bag upon a ſtick reſting horizontally on two wooden forks. A weight ſuſpended from the bottom of the bag, ſqueezes out the juice, which is a powerful poi-ſon. The fœculum is then waſhed, dried, and paſſed through a ſieve. Baked and toaſted on a gridiron, it forms the *Caſſava*-bread: Expoſed to heat, in a baſon, and moiſtened with water, it takes, while it dries, a granulous form, in which it is called *Couac*: The juice which was ſqueezed from the bag, depoſites ſlowly, a very fine fœcu-lum of a ſweet taſte, which is uſed in paſtry, and is called *Mouſſache*.

Sag

AGO is a fœculum, obtained from the pith of a palm-
known in the Molucca-Iſlands by the name of *Lan-*
It is imported into Europe, from the Eaſt Indies. Sago.
extracted by ſplitting the tree that affords it. It is
ſcraped down; put into a funnel formed of the bark
he tree; placed upon a hair-ſieve; and expoſed to a
teous affuſion of water. This water paſſes through
ſieve, and carries with it the finer parts of the pith;
ing only the fibrous matter on the ſieve. It is received
pots, in which it ſoon depoſites the fœculum ſuſ-
ded in it. It is then decanted off; and the moiſt fœ-
um is paſſed through ſmall plates perforated with holes,
m which it takes a granulated form. It is, then dried
fire, the action of which gives a reddiſh colour to the
faces of the grains. In this granulated form, is this
ſtance brought into Europe. It makes with milk,
th, or white wine, ſoups or a ſort of pap, which are
en as light and highly nutritious, to perſons who are
ill, as to be incapable of taking other food. It is uſed,
, in puddings.

The fœculum of WHEAT, has received the name of Wheat.
rch. Every ear of wheat, freed from the chaff, con-
of three parts, a *fœculum*, a *gluten*, and a portion of
charine matter. If bruiſed to a powder, wrought into
aſte, and in this form expoſed to the action of water
ning from a cock; wheat will impregnate the water
h a fine white matter, from which it will receive the
our and conſiſtency of milk. This whitening matter,
water will ſlowly depoſite by ſtanding: and this is the
ulum of wheat. It is extremely fine, is ſoft to the
ch, and has no ſenſible taſte. It forms always more
n one-half of the flour or powder of wheat. By

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treatment with nitric acid, it affords oxalic acid. In the alteration produced in bread by leaven, this matter ſeems to undergo an incipient, acid fermentation.

All theſe different fœcula are ſtill but compounds of hydrogen with carbon. It is their tendency to afford these two matters in every decompoſition, which fits them for the ſuſtenance of animal life. The vegetables, in whoſe ſubſtance they are contained, prove more or leſs uſeful for food, according as the fœcula are more or leſs copious, and more or leſs free from improper mixture.

14. Gluten.

XIV. GLUTEN is another *immediate principle in vegetables*. In grains, it co-exiſts with *fœculum*, and *ſaccharine ſubſtance*. It appears to be a compound of azote or nitrogen, with hydrogen and carbon. As poſſeſſing azote, it differs eſſentially from moſt other vegetable principles, and approaches to the character of animal matters. It is elaſtic, ductile; ſeemingly fibrous or membranous; inſoluble in water, imperfectly ſoluble in alcohol; putrefiable like an animal ſubſtance; ſubject to take, like animal matters, a yellow colour from the contact of nitric acid; and affording under the farther action of nitric, at laſt oxalic acid. Wheat appears to contain it in a greater proportion than moſt other grains. It exiſts in the beſt flour; in proportion of—from a *fifth* to a *third* part. It is as containing this matter in ſuch a proportion, that the flour of wheat is more wholeſome and nutritious, as an article of food, than oats, potatoes, or any other farinaceous ſubſtance. The taſte of GLUTEN is inſipid. It ſwells aſtoniſhingly, when it is expoſed to a force of heat, ſufficient to dry it rapidly. Dried by a gentle heat, it becomes ſemi-tranſparent and hard, like animal glue, and breaks with a degree of noiſe, and with a ſmooth fracture. In this

ſtate,

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, it exhibits, if laid on a coal, all the characters of
imal matter, crackles, ſwells, liquefies, is agitated,
urns like a feather, or a piece of horn. It yields by
ation, water, ammoniacal carbonate, an empyreu-
oil, and a carbonaceous reſidue. By water, it is not
ved: yet, perhaps, water is an eſſential principle in
mpoſition. It is ſoluble in the ſolutions of potaſh
da. The mineral acids alſo diſſolve it. Azotic and
ards nitrous, gas, are evolved by the action of the
acid upon this Gluten. The ſulphuric and muriatic
produce with it, a brown ſolution, from which an oil
rwards to be obtained.

15.
Colouring
Matter.

/. COLOURING MATTER always accompanies theſe
ples of Vegetables. It is, ſometimes, ſoluble in wa-
nd ſometimes, ſubject to yield, only to the action of
s, oils, or alcohol. It has a tendency to combine
alumine, oxydes, &c. It is capable of more or leſs
t combination with the contexture of all bodies, ani-
r vegetable. This COLOURING MATTER is, in its
te nature, and moſt delicate combinations, utterly un-
n. The experiments of Fourcroy and others, have,
er, evinced; that, by the addition of a certain
ty of oxygen, to bodies which were previouſly un-
ed, whether theſe bodies be vegetable or mineral,—
colour is developed; that a ſecond quantity of oxy-
ing ſuperadded gives a yellow colour; and that, when
portion of oxygen is ſtill augmented, the colour be-
red. But, it appears, likewiſe, that bodies entirely
e of oxygen, ſuch as metals in their pure metallic
re not colourleſs. It does not certainly appear, that,
any one part of material bodies, by the abſence of

Book VIII. Sect. V. which, colour would be entirely taken away. It i
tain, that oxygen cannot be the univerſal colouring m
though there be, indeed, certain phænomena of c
in the production of which, oxygen acts an imp
part.

16. Wood. XVI. The Ligneous Part or Wood of veget
is the univerſal ſolid baſis of all vegetable organiz
In hard vegetables, it is much more copious, than in
which are ſoft. It is inſoluble in water. It affor
diſtillation, that particular acid which is called—*the*
ligneous. It appears to be the laſt product of the ela
tion of vegetable organs. Treated with the nitric
it is capable of paſſing into three or four different ſta
acidity. It is, however, inſoluble in water and
other menſtrua. It ſhould ſeem, that this Ligneous
ter conſiſts of mucilage united with an extraordinar
portion of oxygen.

All the matters in the compoſition of vegetables, a
ducible to theſe fifteen Immediate Principles. Befor
truth and generalization had been introduced into Che
Science by the diſcoveries of Lavoisier, it wa
known that theſe principles were ſuſceptible of a
into others more ſimple. We now know hydrogen
bon, oxygen, and in ſome, a little azote, to be th
component principles of all vegetable matter. The

combinations of which theſe admit, are innumerable. It is not impoſſible, but future inveſtigation and diſcovery may inform us of the exiſtence of other compounds beſide thoſe fifteen in which vegetation unites hydrogen, carbon, oxygen and azote in peculiar modifications.

SECTION SIXTH.

OF ALCOHOL, &c.

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1.
Origin of
Alcohol.

ALL Vegetables ſubſtances containing any qua
that particular modification of the compound of hy
with carbon, which forms SUGAR;—are liable,
tain circumſtances, to undergo a ſeries of chang
which this ſugar becomes, *firſt*, more ſenſibly p
nant in their compoſition, and is *then*, decompoſed
evolution of its carbon into carbonic-acid-gas; an
tion that is always followed by the formation of a n
ſomewhat leſs volatile hydro-carbonous compound.
changes take place in the heat of from 55° to 65°
renheit. The preſence of water is always nece
their exhibition. Its decompoſition affords that
which is generally wanted to make the ſaccharine
in the firſt inſtance, develope itſelf,—and afterw
acidify the carbon which is evolved from the ſac
ſolution. In conſequence of this extrication of t
bon and oxygen: the intimate vegetable ſtructu
moſt wholly deſtroyed. The formation of ALCO
the moſt remarkable effect that enſues in the liq
of which the carbonic-acid-gas has thus eſcaped.
whole ſeries of changes in ſaccharine vegetable mat
denominated SPIRITUOUS FERMENTATION.

2.
Its charac-
ter.

ALCOHOL, thus obtained, is a white liquid, of a
ſmell, a hot and acrid taſte. It is convertible into
by the heat of 176°. Fahrenheit, It is

the contact of flame, at any temperature. When burning, it affords a large proportion of water, and a portion of carbonic acid, and diffuſes no ſmoke. It is miſcible in any proportion of water; from which there is an expulſion of air and caloric, while the union takes place. It diſſolves the pure cauſtic alkalis, deliqueſcent neutral ſalts, and many metallic ſalts. From vegetables, it extracts their volatile oil, aroma, reſin, balſam, a part of their gum-reſin, and ſeveral colouring matters.

3.
Æther.

The acids when brought into contact with ALCOHOL, reſign to it their oxygen. By this decompoſition, the nature of the ALCOHOL itſelf, is, of courſe, changed; and it becomes ÆTHER. ÆTHER is a fluid lighter than ALCOHOL; of a ſtrong, ſweet ſmell; of a hot, pungent taſte; and ſuſceptible of extraordinary expanſion. Such is its volatility; that, if ſtirred or ſhaken, it is inſtantly diſſipated. In its evaporation, it is capable of abſorbing heat ſo rapidly and with ſuch energy from water, as to produce in the water in a phial upon the exterior ſurfaces of which the evaporating ÆTHER is poured,—a degree of cold ſufficient for congelation. ÆTHER is not alcohol, completely ſaturated with oxygen: For, it is eaſily inflamed—by heating in the open air, by the contact of any burning body, or by the electric ſpark. It is probable, that in the compoſition of æther, a portion of the combuſtible acid baſe always enters into the new compound, together with a proportion of its oxygen; but that the oxygen and the baſe no longer remain in their original acid combination; being ſeparated, and again joined in a new triple compound. The ſulphuric acid is chiefly employed in the preparation of æther. Muriatic and nitric æthers diſplay ſome properties by which each is peculiarly diſcriminated. ÆTHER in in its gazeous ſtate may be made to paſs through water without loſing its ſmell or inflammability.

4.
Various relations of Alcohol.

Alcohol combines readily with boracic acid; and in its combination with this acid, burns with a green flame. Of Carbonic-acid-gas, it abſorbs a quantity more than equal to itſelf in bulk. It diſſolves nitric and muriatic neutral ſalts with conſiderable energy,—ſulphuric neutral ſalts, much leſs eaſily. It is combinable with moſt of the ammoniacal neutral ſalts Deliqueſcent, earthy ſalts are eaſily diſſolved in it. With ſalts of copper, it burns with a beautiful green flame. Various other metallic ſalts are eaſily ſoluble in alcohol. It does not diſſolve ſulphur, either in maſſes or in powder. But, theſe two bodies combine, if brought into contact, while they are both in a vaporous ſtate. It acts not on pure metals, nor on metallic oxydes. It acts always with more or leſs energy on vegetable matters,—detaching into combinations with itſelf, the ſaccharine and ſaponaceous extracts,—and combining with ſtill greater readineſs with volatile oil, aroma, camphor and reſin. The diſtillation of alcohol on a water bath, with odorous plants, produces theſe laſt combinations.

5.
Uſes of Alcohol.

Alcohol is the ſpirituous principle of all ſtrong drink; brandy, wine, rum, whiſky, cyder, ales, &c. It is combined with oils and raiſins in thoſe which are called *Drying Varniſhes*. It has been uſed in thermometers, and for many other uſes. It is a powerful ſtimulant, but inſufficient in its efficacy, and highly dangerous in its intemperate uſe. Æther is adminiſtered as a tonic and antiſpaſmodic remedy of great energy; though not always with effects the moſt beneficial.

SECTION SEVENTH.

MPOUNDS WHICH ARE REGARDED AS THE IMMEDIATE PRINCIPLES OF ANIMAL MATTERS.

Immediate Principles of Animal Subſtance.

NIMAL SUBSTANCES are, all, underſtood to be comnds of theſe four principles,—carbon, hydrogen, oxyn, and azote. But, certain intimate combinations of ſe ſimple principles, preſent themſelves, the moſt ſtrikly, to notice, in the firſt analyſis of animal matters. til chemiſtry was improved to its preſent enlargement of nce, by the diſcoveries of LAVOISIER, compounds re; here, as in the other kingdoms of nature, regarded ſimple ſubſtances; and the following matters, of which ochemical hiſtory ſhall be, here, briefly ſubjoined, re conſidered as the IMMEDIATE PRINCIPLES of all mal bodies.

1. Blood.

I. BLOOD is, obviouſly, one of the firſt and moſt imtant of theſe ſecondary principles. In man, quadrupeds, l birds, it is hot at the temperature of 104° Fahr.; in parous quadrupeds, ſerpents, and fiſhes, at the mean perature of the local ſituations which they inhabit. hen diſcharged from a blood-veſſel into the open air; it rates, almoſt inſtantaneouſly, into the three different ts of—*white ſerum*,—*red ſerum*,—and *fibrous matter* or ine.—The *white ſerum* appears to be, in ſome ſort, of alkaline character, and to contain oxygen, in an intite combination with it,—which gives it, a tendency to coagulate

coagulate by fire, metallic oxydes, &c. The *red ſerum* or colouring part of the blood is of the ſame general nature as the *white*, but differs in poſſeſſing in it, a large proportion of oxyde of iron. The fibrina is ſpontaneouſly concreſcible by cold, and ſoluble in alkalis. Theſe properties of the different parts of the blood, may be conſidered as belonging to it all, in general. The blood is hot from the continual decompoſition of gas-oxygen, as it is formed and as it paſſes through the veſſels;—for Caloric is thus conſtantly evolved; and ſubſtances which as they paſſed from the ſtomach to the lungs, were gazeous or fluid, are continually falling into a ſtate of fixity, in order to renew the ſolids. It is probable, that the renovation of the blood by chyle, and the converſion of chyle into animal matter, are owing to the diſengagement of a large quantity of carbon and hydrogen in the lungs.

2. Milk.

II. MILK, another peculiar animal matter; is a white fluid, mild, and ſaccharine; a mixture of ſerum, cheeſe, and butter; a genuine animal emulſion. In the ſerum, there exiſts an incipient ſugar which is known by the name of *Sugar of Milk*. It contains phoſphate of lime, in a proportion much larger, than in any of the other humours. The *Cheeſe* is ſimply what is called *Albuminous matter*. The *Butter* is a concrete oil which ſeems to be ſolid, and ſeparable from *milk* by motion alone, ſolely in conſequence of the abſorption of oxygen from the atmoſphere, during the formation of the cream. Milk, diſtilled by the heat of a water-bath, affords an inſipid, inodorous phlegm, ſuſceptible of putrefaction. By a heat ſomewhat ſtronger, it is coagulated, like blood. In diſtillation by naked fire, it affords acid, fluid

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carbonate of ammoniac: Its reſidual coal contains ſmall ſions of potaſh, muriate of potaſh, and calcareous phate. In a very hot temperature, milk is liable to ſs into a ſtate of ſpirituous fermentation, in which a ſpi- and an acid are, at once, evolved. Another degree of at, ſeparates the caſeous part in pellicles which riſe to e ſurface. Acids alſo ſeparate the caſeous part. *Rennet* mixture of milk formed in the ſtomachs of calves— ith the gaſtric juice,—is employed as the beſt coagulat- g agent, in the ordinary preparation of cheeſe. The um, or *whey* drawn off from the coagulated caſeous part, nd clarified with *white of eggs*, has a mild taſte, and con- ins a quantity of ſaccharine matter which, by a farther roceſs, may be obtained ſeparate. A peculiar acid, which been already deſcribed under the appellation of *Lactic cid* is developed by a ſpontaneous acid fermentation which ll take place in this whey,—and even in milk at the tem- ture of 80°. Evaporation of the ſour whey to an part of its firſt quantity; the precipitation of its y part, by lime-water; the ſeparation of the lime by acid; evaporation of the liquid to the conſiſtency y; and the precipitation of the ſaccharine part and traneous matters with alcohol; yielded, in the laſt this proceſs, the pure *lactic acid*, in ſolution in lcohol. The properties of this acid have been already ined. The *ſaccharine part* exiſts, alſo, in whey, not cheeſe or the butter. It is commonly extracted in Switzerland; and is ſold under the appellation *of Milk*. It appears in various degrees of pu- in which it is more or leſs free from the intermix- the other ingredients of milk. Heated with ni- acid, it affords a peculiar compound acid which has been

[illegible] combined with oxygen in confide
[illegible] with *Sebacic Acid.* It is a compound of
[illegible] acid, and water. These, again,
[illegible]ogen, carbon, azote, and oxygen.
[illegible] body, are,—to maintain the heat of
[illegible] the viſcera from external cold,—as
[illegible]hment to the animal, in want, ſickne

V. Urine is an excrementitious fluid, m
oured, acrid, and ſaline; remarkable for
which it contains of uncombined phoſphor
phate of ſoda, ammoniac, and lime; ſtill m
for containing a peculiar acid, which has n
found in the other animal humours. This
the *Lithic Acid*, and is the baſis of thoſe ſto
which are formed in the reins or bladder,
called *Lithiaſis.*

VI. GLUTEN is another immediate prin
ſubſtances. It is eaſily ſeparated by boiling
ſolution of it, cools into a jelly. It forms
the white organs of animals. It is a com
drogen, carbon, and azote. It affords all
jellies which are prepared for the table, and
mal glues which are employed in the arts.

ſolid ſuſtance of the animal body. Albumen, as it appears in this part of the ſyſtem, is concreſcible by heat, by acids, by oxydes, and in general by whatever affords a ſufficient depoſition of oxygen, to enter into it. By alkalis, it is diſſolved. It exiſts in a ſtate of more or leſs complete oxygenation and condenſation, in the membranes, the tendons, the griſtles, and all the white parts in general. The Fibrina is inſoluble in water at any temperature; contains a large proportion of azote; is condenſed, concreted, and organized in muſcular fleſh, which may be regarded as the reſervoir in which all the fibrous matter of the blood is depoſited. The muſcles are the proper ſecretory organs of this matter.

VIII. The Osseous ſubſtance of animal bodies, appears to be formed by the very copious depoſition of phoſphate of lime, ſecreted from the blood, in a gelatinous and fibrous parenchyma. 8. Oſſeous Subſtance.

In Animal, as in *vegetable* ſubſtances, there is nothing more remarkable, than the fewneſs of the ſimple elementary principles, the multiplicity of the compounds, and the very various qualities which the varied modifications of the ſame elements, are made to exhibit. Vegetation and animal life appear to be capable of combining the principles of carbon, azote, hydrogen, and oxygen, in every poſſible variety of proportions. If the complexity of animal and vegetable matters have ſuch ſimplicity in their firſt origin; it is ſurely not too much to expect, that chemical analyſis may, one day, exceedingly diminiſh the preſent number of ſuppoſed ſimple ſubſtances.

ELEMENTS OF CHEMISTRY.

BOOK NINTH.

PPLICATION OF CHEMICAL SCIENCE TO EXPLAIN—THE GENERAL FACTS OF GEOLOGY,—THE LAWS OF VEGETATION,—THE FUNCTIONS OF THE ANIMAL ECONOMY,—AND THE PRACTICE OF THE POPULAR, CHEMICAL ARTS.

PRELIMINARY OBSERVATIONS.

1.
Utility of Elementary Knowledge

HE, who, without previous elementary knowledge, ſurveys either the appearances of Nature, or the mplex operations of Art, will hardly be able to diſtin- ſh their order, their ends, their connexions, or their tual dependencies. Confuſion and inextricable per- xity muſt appear to pervade all that is before him. He nts the requiſite key; and it is, therefore, impoſſible r him to read the cyphered page. Should you even en- vour to explain the appearances to ſuch a perſon, as they cur; his want of the previouſly requiſite, fundamental owledge, makes it impoſſible for him to comprehend ur meaning.

2.
It is perplexing, to attempt to teach the

In conſiſtency with this general fact, it has been found; at, whether in Books, or in Lectures accompanied with e exhibition of experiments; every attempt to teach the

more

complex application of Chemiſtry before its general elements be known.

more complex applications of Chemiſtry, withou
explaining its general elements,—is, unavoidabl
barraſſing, diſguſting, and very imperfectly inſtru
the learner. A few examples would have happil
trated and enforced the general truths. In the maz
multiplicity of examples and great complexity i
particular caſe; the unwindings from the clue of S
were ſoon loſt to the ſtudent's inexperienced eye.

3. What has been done in this work.

For theſe reaſons, it has been endeavoured in t
ceding part of this work, to explain the princ
Chemical Science; without bewildering the reader
quent and tedious digreſſions into the detail of the c
arts, or into thoſe curious applications of Chemiſtry, i
it is employed to explain the great phœnomena of

4. Propoſed account of the applications of Chemical Science.

Yet, without the explication of theſe phœnome
of the Arts in which Chemiſtry adminiſters the
the uſes of life,—ſuch a work as the preſent wo
egregiouſly defective. In this place, therefore, w
upon the conſideration of—the moſt general C
Laws which reſpect the ſtructure of the earth, t
ous appearances of the atmoſphere, the changes o
tation, and the functions of animal life. The mo
plex, chemical arts, of Agriculture, Dyeing,
ing, Tanning, Pottery, Mining, the Making of S
fall, alſo, to be here deſcribed. The difficult An
Mineral Waters, comes into the ſame claſs of the m
neral applications of chemiſtry. The arts of B
Diſtillation, Sugar-baking, and the preparation of
are to be briefly treated of, in the ſame concludin
ſion of this work.

SECTION FIRST.

HE INFLUENCE OF CHEMICAL LAWS IN THE UCTURE AND EXTERIOR APPEARANCES OF HE EARTH.

Book
Sect.
I.
Immen
of the
verſe

IIs material Univerſe preſents itſelf to enlarged
an obſervation, as an immenſe aſſemblage of ſyſ-
within ſyſtems; each complete in itſelf, yet con-
ed by numberleſs relations, with all around it; a
r still including a leſs, till all material Nature is, in
aſt grand reſult, comprehended in—One Whole.

2.
This pl
tary Syſt

he laws of this vaſt Univerſe, can be ſtudied by us,
in its inferior ſubdiviſions. We conceive of it, as
vided into planetary ſyſtems. Comets are the only
s of combination among theſe ſyſtems, with which
ave any tolerable acquaintance. It is from the con-
tion of the appearances of that particular planetary
m, to which our Earth belongs, that all our
ge concerning the laws of material Nature, is de-
d. Of the other planets and the Sun around which
move;—we know little more than;—that a central
VITATION, proportionate to the maſſes and the
s of the diſtances, makes the parts of this
ary ſyſtem, tend, in motion, to their common
e;—that, on the other hand, the continual ef-
f matter to diffuſe itſelf into its primigenial atoms,
ghout the vacuity of ſpace,—oppoſes—to that *cen-*
ravitation,—a centrifugal motion, which, by its con-

teſt with the former, produces the different movem
all the planets, in their orbits, and round the Sun ; a
all the varied appearances of theſe movements, are
tible of being obſerved and recorded with ſufficie
ciſion, by the vigilance of Aſtronomy.

3.
The Earth, and the laws by which its exiſtence is preſerved, and its changes are carried on.

But, when we confine our views to the EARTH
we inhabit, we diſcover the operation of a grea
verſity of laws. We perceive—an atmoſphere o
impalpable ſubſtance,—a fluid ocean with nun
ſtreams of cold liquid matter, tending, with great
to inceſſant motion,—a ſolid globe of which the
gation, is, through all its parts, conſiderably fixed,
without a ſtrong force of impulſe, to be deſtroye
ſee, now, the force of *gravitation*,—now an attract
tween the intimate component particles of bodies,
has the name of *Chemical*,—now the powers of
city,—and now thoſe myſterious relations which ar
Magnetical,—all concurring in the varied changes
take place in inanimate and unorganized bodies.
the things of this material globe intermingled toge
particularly in the interior ſtructure of the EAR
termingled often in a diſorder, of which neither pre
pearances, nor any conceivable modification of the
of any one of the great general laws, can afford a
tory explanation. But, above all, we ſee, that, in t
mate contact of parts, which takes place in the im
mutual reactions of the component parts of the ſu
of this terreſtrial globe,—almoſt all other influen
abſolutely loſt in the predominancy of the Laws c
miſtry.

4.
Chemical view of its ſolid parts.

I. If we contemplate the SOLID PARTS
diſtinct from the waters flowing on its ſurf

e ærial matters, circumfuſed around it; we per-
be arranged with an irregularity of diſtribution,
ly well excite our wonder, and fix our at-

5.
Their genera, &c.

s, SALTS, METALS, and the more ea-
BUSTIBLE bodies,—either in *lapideous* or in
ggregation, or elſe in a ſtate of comminution,
that aggregation has been, for as much as was
y mechanical impulſe, deſtroyed,—are its only
mponent, ſolid parts. With theſe, are, here and
mingled the remains of organized bodies, animal
ble, haſtening with a more or leſs rapid pro-
entire diſſolution.

6.
Primary and *Secondary* Rocks.

ſtony matters, there are two remarkable claſſes:
s compoſed of *ſiliceous* and *argillaceous* earths,
ogether, at the moſt profound depths, or in the
the loftieſt mountains: or (2.) ROCKS com-
lcareous earth, with various mixtures of ſilice-
gillaceous compounds, derived evidently from the
tion of the former. The firſt of theſe claſſes
, are by Mineralogiſts, denominated PRIMARY,
ppoſed to be prior in origin. The others are
ONDARY. The PRIMARY Rocks are far
mly exhibiting either *ſiliceous* or *argillaceous*
mogeneous and unmixed ſtratification. They
ſe elements,—in columns almoſt vertical, or in
e or leſs perfectly horizontal in their diſpoſi-
bined with ſalts, contaminated with metals,
gether in an endleſs diverſity of compoſition,—
tals diffuſed in veins, throughout their ſtrata, in
ety of circumſtances,—and exhibiting, alſo, an
e of other earths of the SECONDARY charac-
ECONDARY ROCKS appear always—in ſtrata

of

of a horizontal direction more or leſs perfect ; and preſent calcareous ſtone, holding animal and vegetable petrifactions in its ſtructure, indurated clays in which animal remains are equally intermingled, or grit ſtones in which ſiliceous ſand is often mixed with argillaceous earth: They are, alſo, interſected by veins of coal. Would we find PRIMARY ROCKS? we muſt look to the heights of Caucaſus, to the Alps, the Andes, aad all the other loftier mountains, whether in iſlands or in continents. The SECONDARY ſtrata occupy the lower regions of the ſurface of the EARTH, but deſcend not to that extraordinary depth at which it is uſual, in conſequence of general experience, to look for ſiliceous matters alone. Freeſtone, lime, and pit-coal are uſually found to exiſt together,—becauſe they are, all, grand ingredients in the SECONDARY ſtrata.

7. Chemical and phyſical characters of rocks.

Colour, denſity, hardneſs, the appearances of their fractures—when they are broken, the arrangement of their columns, ſtrata, nodules &c., their chemical compoſition, &c., afford a variety of means, to enable us to diſtinguiſh all the diverſities of theſe ſtones from one another. Chemical diſtinctions form the grand and moſt permanent characters. The inferior, more obvious, and more uncertain ones are of a different nature.

8. Siliceous rocks.

That SILICE or ſiliceous earth, of which the chemical characters have been above deſcribed, ſcarcely exiſts any where in Nature, in a ſtate of perfect purity. *Quartz*, a glittering white ſtone, compoſed of layers of cryſtals,—and *Rock-cryſtal*, which is found on the ſurface of rocks, in a cryſtalline form that has, to the ignorant, the appearance of being artificial,—are thoſe natural forms in which this earth ſeems to be the pureſt.

flint, all thoſe which are called the

rytes, in a ſimilar ſtate of combination or diſtribu-
on,—the others, alſo, in alliance with ſilice,—except
ly ſtrontiana which appears in ſituations, in which lime
naturally to be expected. They never exhibit them-
lves in extenſive ſtrata ; and they are not, any more than
e fixed ALKALIS, to be regarded as grand principles in the
compoſition of the whole maſs of the earth.

12.
Metals.

The METALS preſent themſelves in aſſociation with
e ſiliceous matter of the globe. In compariſon with
e earths, they compoſe but a ſmall proportion of its maſs.
on and copper, but eſpecially the former, are very pleni-
fully diſperſed at the ſurface of the Earth, as well as in
intimate ſtructure of very many rocks and ſtones.
old, ſilver, tin, and the other metals, are more rare.
d is conſiderably abundant. Like the earths, the *metals*
ſeldom found in Nature, in any large quantity, in a
ſtate. They aſſume, all, a wonderful diverſity of
ical characters.

13.
Sulphur, &c

PHUR, phoſphor, diamond, hydrogen in a ſolid
e, are diſperſed over the globe, in quantities much
er, than thoſe of the ſubſtances above mentioned.
ur is found in the vicinity of volcanoes. *Diamonds*
found imbedded in ſome few mines. The other two
ces are to be looked for in compounds.

OND, not in its pure form, but in its oxygenous
tions of *coal* and *carbonic acid*, enters very exten-
into the compoſition of the ſecondary ſtrata of the
In the various ſorts of *pit-coal* and of bitumen, its
aceous ſpecies is joined with hydrogen. In the
bitumens, the combination of hydrogen and carbon,
pit-coals, the carbonaceous form of the *oxygenated*
ND,—is the principal ingredient. The ſtrata of *pit-*
coal,

coal, as of *peat* and *turf*, are, in every region of the globe, extenſive. They enter largely into the compoſition of thoſe which are accounted its SECONDARY ſtrata. Coal is ever more or leſs nearly aſſociated with calcareous rocks. Lime ſtone contains, very generally, a large proportion of carbonaceous matter. *Sulphur* is, in compounds, very copious in the mineral kingdom of Nature, but forms no vaſt ſtrata by itſelf.

14. Alkalis and Acids.

The ALKALIS and ACIDS, except perhaps *ſoda* or *natron*, and ſome *metallic acids*, are ſcarcely to be found pure in Nature. In combinations, they occur more frequently. Common ſalt or muriate of ſoda is dug in extenſive mines, in Poland, Hungary, and other countries. The metals appear every where, throughout Nature, in combination with the acids. There are many native aluminous and calcareous neutral ſalts, compounds into which the acids always enter. *Magneſia* and *barytes* ſcarcely occur, but in acid combinations.

Such are the component parts of the ſtructure of the whole ſolid earth, for as much, as it has, yet, become known to man.

15. Aqueous parts of the globe.

II. But, WATER, the compound of hydrogen with oxygen in the proportion of 0,15 parts of the former to 0,85 of the latter, forms a large part of the matter toward the ſurface of the Earth. It is diffuſed in the ocean, in lakes, in rivers, in ſprings. It exhales in vapours. It is condenſed in rains, hails, ſnows, and dews. It is diſperſed by its ſubtle inſinuation, and by its continual tendency to an equilibrium, over the whole ſurface of the globe. Within the range of temperature between 32° and 212°. Fahrenheit, it retains its natural fluidity, and diſſolves any other ſubſtance that is capable of being attenuated to he ſame ſpecific weight. Salts, metallic matters, earths, gen airs by extraordinary condenſation, hence mingle with it. In the ocean, it contains ſuch a quantity of nagneſian and alkaline ſalts, as is ſufficient to prevent the oxious, putreſcent diſſolution of the innumerable bodies, nimal and vegetable, which are diſperſed in it. In rivers, t carries down earths and metals in its courſe. In thoſe which are called *mineral ſprings*, it holds in ſuſpenſion, in olution, or in combination, metallic and ſaline bodies of ll ſorts, ſulphur, bitumens, &c. Bitumens float on it, in certain lakes: And it has been, in the ſame manner, found to hold in ſolution, boracic acid. Its diſtribution over the earth, in that particular manner in which we ſee it, appears to be owing—to the inequalities in the earth's ſurface,—to the inceſſant tendencies of this fluid to a general equilibrium,—the varieties of denſity in the different terrene bodies among which it paſſes,—the influence of the diſperſion of rains, and the fluctuations of the atmoſphere,—the occaſional decompoſitions and compoſitions of water, which are effected by the chemical energies of Nature,—the agency of the electrical fluid,—the management of human art,—the exiſtence of cavernous reſervoirs and volcanic fires in the bowels of the earth,—and the force of the diſtant attractions of the moon and other planetary bodies. Its quantity may have been at different times, augmented or diminiſhed, by great convulſions of this globe. But, it is exceedingly probable, that, in the *ordinary* courſe of Nature, the quantity of the aqueous part of the globe, paſſes, indeed, through continual changes, yet is neither augmented nor diminiſhed.

16. Air; its compoſition.

III. Around this earth and water, to a conſiderable but uncertain height, is circumfuſed an ATMOSPHERE of matters rarefied by caloric into that which has been called a ſtate of gazeous fluidity. This atmoſphere is, as it were, one vaſt ocean of airs. Its ordinary conſtituents are *Gas-oxygen* in the proportion of 0,27, with *Gas Azote* in that of 0,73. But *carbonic-acid-gas* in large quantities, and contiguous to the ſurface of the Earth,—*Gas-hydrogen* likewiſe in large quantity, and in a ſtate in which it tends continually to riſe to the extreme height of the atmoſphere,—*water* in various ſtates of *vaporization*,—all the *gazefiable acids* in a gazeous form, and in greater or ſmaller quantity,—*Ammoniac-gas*,—*æther*,—and *alcohol*—are alſo diffuſed in this vaſt expanſion of ærial matters. With theſe are intermingled portions of every ſolid or aqueous matter that, in extreme comminution, is capable of ſuſpenſion in air. Earths, metals, alkalis, neutral ſalts, mixtures of earths with alkalis, &c. are all, in various portions, diſperſed through the lower regions of the atmoſphere. Light, caloric, and electricity, are continually tranſmitted through this atmoſphere, or retained in it, according to their reſpective laws. Thoſe ſecondary-elements, too, which form the immediate principles of animal and vegetable bodies, are, in ſmaller or larger portions, often evolved into the air. It is not impoſſible but that, in thoſe upper regions of the atmoſphere, which are removed above the reach of human experiment, there may exiſt gazeous fluids ſomewhat different in character, from any of thoſe with which we are, as yet, acquainted.

17. Laws by which it is affected.

This mingled aſſemblage of ærial matters, that is diffuſed around our globe, is, by

the centre of the earth, and by the compara-
ebleneſs of its aggregation, neceſſarily much more
than the *earth* and *water*, to be agitated by the
ions, whatever they are, of the Sun, Moon, and
lanetary bodies. It is ſubject to be particularly af-
by the heat and light tranſmitted from the Sun and
. It is influenced by thoſe changes which are con-
going on in the waters, at the ſurface, and even
bowels of the earth. Within itſelf, from the mix-
f ſubſtances which it contains, new commotions in-
ly ariſe. Its component parts are in that ſtate of
in which the chemical attractions act with the
t oppoſition; and innumerable chemical changes
n this account, for ever taking place throughout
ſtrata of air by which this ſolid globe is ſur-
d.

18.
Its moſt ſtriking phænomena

onſequence of this compoſition and theſe relations
atmoſphere, it exhibits a number of grand PHÆ-
NA, which are the ſubjects of conſtant obſervation,
which the ſucceſſions and the ſubtle relations are
m being, all, as yet, ſufficiently underſtood. A
ion in the relative qualities of its ingredients, is one
ſe PHÆNOMENA; and, by it, gas-*oxygen*, gas-*azote*,
ic-acid-gas, gas-*hydrogen*, &c. exiſt, each, in an
rdinary proportion,—now, in this place,—now in
rendering the air—here, noxious to animals and ve-
s,—there eminently ſalutary,—in its lower ſtrata,
denſe and ponderous, in its upper ſtrata lighter,
fluctuating, more apt for the tranſmiſſion of light
loric. The *variation in the relative quantities* of the
ients of the atmoſphere, is, in ſhort, a principal fact
production of almoſt all the remarkable changes

which take place in it. Even this alone would be ſufficient to give riſe to moſt of the more intereſting appearances which it forces upon our notice.—The *different denſities and gravities of its different ingredients*, conſtitute perhaps the *ſecond* moſt ſtriking thing to be conſidered in reſpect of this atmoſphere. Light, caloric, electricity acknowledge not the ſame laws of gravitation which govern the movements of its other component parts: Caloric, however, in its union with the various gazeous baſes, in various proportions, produces all that diverſity of weight and denſity which diſtinguiſhes the different ſtrata of the air.—The *influence of thoſe changes* which are continually going on, *at the ſurface of the earth*, excites many commotions in theſe ærial ſtrata above it.—The *inequalities* of that ſurface have a great influence on the air, as well as on the waters.—*Attractions* and *impulſes* from the heavenly bodies, do much. Even the inceſſant operation of the functions of animal and vegetable life, varies the ſtate of the atmoſphere. Chemical and electrical agency ſeems to do all the reſt.

19. Winds. Thoſe commotions in this atmoſphere, which are called WINDS, depend upon—the inclination and the movement of the Earth in its orbit,—the influence of the ſun and moon,—the relative poſition of earth and water,—the charges and diſcharges, the courſes, and the equilibria of the electrical fluid,—the chemical changes which continually paſs in the fluctuating ſtrata of the atmoſphere.

20. Vapour. *Water* is raiſed in VAPOUR by ſuch a ſolution of it in caloric,—(a ſolution in which there is an actual chemical combination)—as renders it capable of mingling even with the lighteſt airs, without undergoing a diviſion of its component principles. This vapour may be deſtroyed

in

atmoſphere by contact with bodies having a ſtronger tion for its principles, than theſe principles, in their ous union, have for one another. *Gas-azote* aphing this vapour in certain circumſtances, may at- away its oxygen, to form nitrous air. The more apour is rarefied by heat, the more liable is it to ſuf- chemical decompoſition in the atmoſphere. Perhaps, laſt degree of rarefaction, heat alone may reſolve it its component hydrogen and oxygen. Before it attain this degree of rarefaction, the heat holding it ution may be attracted away into new combinations or electrical: And in this caſe, the vapour will be enſed, ſo as to occupy a lower ſituation in the air, or ips actually to fall in RAIN.—(*Combinations electrical* here mentioned: for, it is ſtill extremely probable, *Electricity is nothing more, than a particularly modified ination of Light and Caloric:* And, why may not theſe ances be ſuſceptible of *different* permanent combina- just as well as—Hydrogen, carbon, and oxygen?—) n is, alſo, formed by the commixture of Gas-*hydrogen* Gas-*oxygen* in the atmoſphere, in circumſtances, in h the reciprocal attractions of the two baſes, are ſuffi- to effect their combination into water. *Snow* is *Rain* ed to a particular ſtate of cryſtallization: perhaps this allization is not effected without the addition of a por- of azote to the water. HAIL is the ſame *Rain* in a ent ſtate of cryſtallization and agglomeration— *an addition* of azote, no doubt, as well as in Any perſon who remarks the different cryſtalliza- of ſalts, according to the difference of circumſtances, hich their ſolutions are evaporated,—may eaſily un- nd how water comes to aſſume the different forms

of

21.
Peculiar theory of the ſtates of the water in the atmoſphere

22.
Rains.

23.
Compoſition of Electricity.

24.
Snow.

25.
Hail.

of rain, ſnow, hail, and even ice. The laws of general gravitation, no doubt, add their influence to that of the chemical attractions, in the production of theſe phœnomena. Whenever *rains* are accompanied with much warmth—beſpeaking the evolution of much caloric ; they are, then probably occaſioned by a new formation of water from gaſes, in the clouds. The colder rains are effected by the mere condenſation of aqueous vapour, that was, before conſiderably denſe. *Electricity* is copiouſly added to caloric in its different ſtate, in the ſuſpenſion of clouds in the upper regions of the atmoſphere. The commotions neceſſary to preſerve the electrical equilibria between one cloud and another,—or between the earth and the clouds, never fail to occaſion rains,—becauſe, as appears in the experiment of forming water from gaſes, by the electric ſpark,—electricity carries with it, the caloric of the gaſes through which it makes its paſſage, or in which it has been detained.

26. Thunders. THUNDERS are the indications which ſignify to the animal ſenſe of hearing, thoſe *chemical changes* in the atmoſphere which are attended with the ſudden tranſition of *caloric* or *electricity*, in great quantity, from one ſtate of combination into another,—*with* the change of the other ſubſtances preſent, from a *gazeous* to a *liquid*, or from a liquid to a *concrete* ſtate, or *vice verſâ*,—*with* the ſudden commixture of two volumes of matter which were, before, ſituate, apart, although contiguous to one another.

27. Lightnings. LIGHTNINGS, whether produced from *Electricity*, or from the inflammation of *Gas-hydrogen*, indicate the combination between light and caloric to be, by whatever means, momentarily broken, and diſplay light in its ſeparate ſtate, yet with an agency of both

t is peculiarly powerful at the moment of their diſ-
. *Meteorous* lights and inflammations are well
n to be generally produced by the ſudden inflamma-
f quantities of *Gas-hydrogen.*

28.
Meteors.

. A grand queſtion now ariſes,—*In what manner*
his Globe brought into the preſent diſtribution of its
—and the preſent relations and order in it changes?

29.
Geology.

any attempt to reſolve this queſtion, we are to rea-
nly upon the agency of its preſent laws. Where
eaſoning ſuppoſes *data* incompatible with them; it
neceſſarily be falſe. If we ſhould attempt to ex-
what was prior to the eſtabliſhment of the preſent
cal and chemical laws of Nature; we ſhall, of courſe
t only the moſt abſurd and unphiloſophical con-
e.

30.
Data for
Geological
enquiries.

origination of this Globe out of a Chaos was the
l belief of the Ancients. Moses, in the beginning
Pentateuch, gives an account of a ſeries of ſucceſ-
anges which he repreſents as the firſt which took
from the moment at which matter was made ſubject
laws it now obeys, to that æra, at which it was
fit for the reſidence and ſupport of animals, and
ving inhabitants, brute and human, placed upon it.
Philoſophers of ancient Greece ſuppoſed the world
e originated—from fire,—from water,—from pri-
ial atoms, having an inherent tendency to com-
n every diverſity of form,—or even to have had no
ing.

31.
Coſmogony
of Moſes
and the ancient
Greeks.

modern times, four different claſſes of ſpeculatiſts
attempted to inveſtigate the circumſtances which
have attended the origin of our Globe. *Divines*
ried to juſtify the truth of the account of *Moſes* by

32.
Coſmogony
of modern
Divines.

an appeal to the laws of Nature: But, *Burnet* and others have been eaſily convicted of ſuppoſing primæval ſtates of things, utterly incompatible with theſe laws. The *aſtronomers* have ſuppoſed, that the origin of the Earth in all its circumſtances, was to be accounted for by the ſubdiviſion of the Sun, the action of ſome comet, or an altered arrangement of the ancient planets. The *foſſiliſts*, loſing themſelves in the conſideration of the ſtrata under the ſurface of the Earth, and the animal and vegetable remains depoſited among theſe, have ſuppoſed derangements and diſpoſitions, ſuch as they could not have imagined to take place, if they had duly comprehended the relations and the general appearances of the whole. Of the *chemiſts*,—Some have imagined the action of fire upon ſolid matter already formed, to have produced the primitive earth, which they believed water to have afterwards altered to its preſent ſtate;—*Others* have conceived the idea of a world perhaps without beginning, but, by the action of internal fires with volcanic orifices, continually lacerated, undermined, and ſubverted, with the conſtant riſe of a new earth the product from thoſe fires by which the former was demoliſhed;—*Others* have fancied a continual ſhifting of the ocean round the globe, by which that which was lately land, becomes now the bottom of the ſea,—and that which is now covered by the ſea, is to become again dry land;—And very lately Mr. Kirwan has publiſhed a work, in which he deduces the origin of the Earth in its preſent form from a general aqueous liquidity of its whole matter,—ſuppoſes the operation of internal fires to have gradually opened reſervoirs for the waters by which the upper ſurface was made dry,—and repreſents a convulſion of the whole globe by which the Southern

32. Aſtronomers.

33. Foſſiliſts.

34. Chemiſts.

35. Kirwan's Geology.

Ocean

forcibly impelled over the Northern Conti- aving produced whatever other appearances he two former hypotheſes, explained.

36. Imperfection of former ſyſtems.

e is not one of all theſe ſyſtems, that is either conſiſtent with the known laws of Nature,— to the utmoſt ſimplicity in the beginning of hich our reſearches may, by due attention to be guided. Let us try whether it be not poſ- ulate, here, more juſtly.

37. Of KIRWAN's.

Water is but a *chemical compound*; we may igin of the exiſtence of material Nature under aws, undoubtedly, backward beyond a ſtate of idity. And the ſyſtem of KIRWAN, is at ect, as not commencing with the extreme pri- licity of things.

38. Of others.

milar reaſons, thoſe ſyſtems muſt, all, be con- rfect, which begin with ſuppoſing the pre- nce of a maſs of ſolids and fluids. And, under , are neceſſarily comprehended all the *Theories* , prior to KIRWAN's.

39. All matter was, at firſt diſſolved in Caloric.

the univerſal belief of philoſophers, that all iviſible into atoms, perhaps infinitely minute. tion, it probably exiſted in ſeparate atoms, g aggregated into maſſes. The ſtructure of rial body, all the changes to which we ſee ect, the comminution and diviſions effected by agency, and the ſolutions of other matters in and caloric, concur to perſuade us, that even of the bodies which we now behold, muſt ally exiſted in the utmoſt conceivable expan- arts.

But, if this be ſo, it cannot poſſibly have been water that was the firſt great ſolvent of all material things. *Water, a compound ſubſtance, could not have exiſtence, till after the primary matter had paſſed through a number of changes.*

The only ſolution in which we have reaſon to ſuppoſe that elementary ſubſtances, ſimple and uncompounded, are capable of ſubſiſting, is that by *caloric* or *heat*. It is by caloric that all ſimple ſubſtances which have been brought from ſolid aggregation to an aeriform ſtate, have been rendered capable of this change. We have even reaſon to ſuppoſe, that, whatever ſolid ſubſtances, ſuch as the earths, have not been gazified by the heat we have been able to apply to them,—have reſiſted this change,—only from our inability to employ heat in that intenſity in which it would, aſſuredly, have expanded them to gas. Even bodies which we have not yet ſucceeded ſo as to diſſolve in caloric, have, however, been comminuted to a ſtate in which they were ſuſceptible of ſuſpenſion in gaſes formed by the agency of caloric. Every ſucceſſive diſcovery in modern chymiſtry, is continually diſplaying to us, a mutual convertibility between gazeous and ſolid ſubſtances, ſuch as may, well, lead us to believe, that whatever is ſolid may have been gazeous, and may be again rendered ſuch.

From all this, it follows, with the ſtrongeſt evidence which can, in this caſe, be obtained; that *the firſt ſtate in which matter exiſted, under its preſent laws, muſt have been in univerſal gazification by Light and Caloric. Caloric,* *Light*, and the *elementary principles* which were to be modified into the various other ſpecies of terreſtrial matter, were

the

nly material ſubſtances then in exiſtence. Theſe to be diverſified and combined into all that variety atters with which our ſenſes are acquainted. In the formation of matter, even Caloric, and the other pri- atoms, were without diſtinction of character. But muſt have been diſtinguiſhed, before theſe laws take place, to which we ſee matter ſtill ſubject.

40. The expulſion of Caloric by gravitation.

The next effect in the formation of the earth, was, ably, the impoſition of that gravitation towards the non centre of what was to become the Earth,— h ſtruck a large portion of the *lumen* and *caloric* from ombination in which they, before, exiſted, with other er,—re-united them in a particularly modified combi- n, as *electricity*,—or perhaps diſmiſſed this ſuperfluous tity of *lumen* and *caloric*, to their proper reſervoir in un.

41. The Origin of chemical Attraction.

At the ſame moment, the new gravitation,—accord- o the differences of local poſition of the gazeous er, *in which* it was infuſed,—and according to the di- ties in the extrication of the *lumen* and *caloric*,— ld neceſſarily occaſion thoſe varieties in the configu- n of particles, and the aggregation of maſſes, upon ch, all the permanent differences in the figure, denſity ſubordinate, mutual relations of material bodies, were ned to depend.

42. Formation of Solids, Fluids, Gaſes.

The coming into *mutual contact*, of the different *ary ſimple matters* which had the moſt powerful, ual attractions, would neceſſarily produce *compounds wo*, *three*, *four*, and *five* principles. Hence, a train of ral proceſſes of compoſition and decompoſition, by ch, in a ſort of conteſt between the *chemical attrac-* and *general gravitation*, was produced that apparent diſorder

diſorder in the maſſive mixtures of ſubſtances, and in the diſpoſition of their ſtrata, which philoſophers have been the moſt puzzled to account for.

In this conteſt between the chemical attractions and general gravitation,—which muſt have taken place, at the inſtant when thoſe attractions began to exert themſelves in the formation of chemical compounds;—the particles of iron were intermingled with the earths, into whoſe rocky aggregations it enters;—the other metallic ſubſtances were formed and irregularly ſcattered, as we find them;—the earths were curiouſly blended together; Acids,—neutral ſalts,—diamond,—water from the combination of hydrogen with oxygen, &c.—were at the ſame time formed.

43. Mixture of Solids, Fluids, and Gaſes.

7. In theſe effects, three great agencies muſt have been principally employed.

Above all others was that of CALORIC,—ſcarcely—or not at all—excluded from any ſolid, however denſe and ponderous,—entering into the compoſition of all the ſofter fluids,—by its combination with water and other ſimilar bodies, the principle of liquidity,—in its unions, the principle on which alone, depends the power of matter to ſubſiſt in a gazeous ſtate,—tending continually from the earth's centre, towards the centre of this ſolar ſyſtem,—but by its union with light, by its accumulation together with light in *electricity*, by its combinations in gaſes, fluids, and ſolids, by the conſtant re-infuſion of it from the ſun, preſerved to be the grand principle of ſalutary change and movement throughout this globe. *What ſo wonderful as the combination of* HEAT *or* CALORIC*—a matter that continually tends from the centre of this earth,—with* LIGHT *or* LUMEN*—a matter which tends inceſſantly towards it! Is not* HEAT *by its conſtant tendency to eſcape from*

44. Explanation of the Centripetal and Centrifugal powers of this planetary ſyſtem.

this

H *towards the* SUN, *the true principle of the gra-*
f *this planet towards that Luminary? On the*
he tendency of all the other matter of this globe to
s centre,—with the general original tendency of
to diffuſe itſelf through empty ſpace,—do not theſe
cies jointly, conſtitute that centrifugal power, by
centripetal force of the *fiery* part *is ſtill reſiſted,*
rſe of the Earth in its orbit, duly regulated?—Are
e this planetary ſyſtem, or even in the whole uni-
ſt two ſpecies of elementary matter; of which one
led SOLAR, *which is* CALORIC, *and tends ſtill to*
f the SUN,—*while the other,* TERRENE *or* PLA-
matter, tends to the reſpective centres of the dif-
nets,—and the mixture and relative arrangements
o matters, neceſſarily produce the mutual attractions
e movements of the Sun and the planets? But,
ll this may be; the ſudden excluſion of caloric
matters, its retention in others, the various de-
hich it was retained in combination with this or
ication of matter, and its inceſſant paſſages by
f chemical affinity, out of one matter into ano-
t of neceſſity have effected much of that com-
f bodies ſimple and bodies compound, that ne-
ok place in the primitive formation of the earth,
a matter of perplexity and admiration to the
hiloſophers.

ial or *gazeous* compounds of other matter with
caloric,—by their eaſy chemical formation and
ion,—by their amazing expanſibility and com-
—by their eaſineſs of mechanical mixture with
ances,—muſt naturally have acted a remarkable
part

[illegible]
[illegible] to be deposited in aqu
[illegible] ſitions and decompoſiti
[illegible] ſtate of fluidity into anoth
[illegible] important, and thoſe wl
[illegible] of all its effects.—
[illegible] than that in many of thoſ
[illegible] philoſophers ſuppoſe the ſt
[illegible] by the operation of fi
[illegible] their origin to water,—th
[illegible]—and water, acting in co
[illegible] ſomewhat different from a
[illegible] to ſee them employed W
[illegible] compoſed in very great q
[illegible] oxygen and hydrogen, which m
[illegible] in immenſe proportions am
[illegible] the earth.

[illegible] oxygenation of all theſe nat
[illegible] and oxygen combined, muſt ha
[illegible] the other effects which were produ
[illegible] of this univerſe.

[illegible] Nothing can be more abſurd than the
[illegible] fancy, that the middle, interior par
[illegible]

Book
Sect.

nation into another. In its ordinary, permanent,
ence, it is ever in combination with ſome matter,
us or in a different form. Did it exiſt in the bowels
earth, in a free uncombined ſtate, or in a ſtate of
ual tranſition; its ſubtilty of nature, and its power
mmuicating that property to thoſe ſubſtances with
it combines, would, of neceſſity, enable it to force
y in great part, from that ſituation towards the ſur-
In combination in gaſes, it cannot poſſibly ſubſiſt
centre of the earth: for, if the force of terreſtrial
tion, could ſuffer any thing gazeous to remain un-
nſed at the centre; yet, that gazeous matter would
ſubtilty, under the ſtrong compreſſion to which it
here be ſubjected,—unavoidably make its eſcape
ſurface. Yet there are, no doubt, in the boſom
earth, ſtores of *oxygenous* and of *oxygenable* ſub-
. Wherever theſe are acceſſible to any other de-
ſable ſubſtance, which contains *caloric* in large
y; a combuſtion may be excited, and an expanſion
ſiable matters may be produced. Hence the origin
canoes and earthquakes. But, nothing could be
oliſh than to conclude from this, that there are
ous ſtores of fires in the bowels of the earth. *The*
ich gives occaſion to earthquakes and volcanoes, is al-
ways from the ſurface.

46.
Origin o
Animals
Vegetabl

is probable that, by the operations above enume-
this ſyſtem of earth, water, and airs, was finally
d for the reception of *animals* and *vegetables*.
, it was probably furniſhed with but a ſmall number
tables, and thoſe ſuch as could the moſt eaſily de-
ir nouriſhment, directly from unelaborated ſolids,
nd liquids. Their number might be ſoon augmented,
and

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and they diffuſed over the whole globe. *Anim* probably poſterior in origin to vegetables. It is able to believe, that the firſt animals of every ſpecies, might be created in maturity of ſtrengt and faculties,—then deſtined to continue their race b ration.

47. The Deluge.

10. It appears, [illegible]ver, from all the phæno thoſe which are cal[illegible]he ſecondary ſtrata of the that, ſince it was clothed with vegetation, and in —it muſt have experienced ſome grand convulſion calcareous, carbonaceous, and bituminous ſtrata remains of animal and vegetable ſubſtances, whic not be depoſited till after the Earth and Seas had be furniſhed with animals and vegetables. Even on ſ where, of all, they are the leaſt to be expected, find the exuviæ of marine animals. Deep in t ſtrata of the northern regions, we meet with rem animals which are believed to have been, at all ti capable of ſubſiſting in the temperature of thoſe c How have theſe things been produced?

None of all theſe appearances are ſuch as to be continual decay and reſtitution of this globe from by a ſucceſſion of convulſions after certain interva the utmoſt, one extraordinary convulſion may ha ſufficient to produce the phænomena. It is prob account of ſome of the appearances of that gra vulſion, which we have in the Scripture-Hiſtory o flood.

That general Deluge might have its origin in pulſe of ſome comet, or in ſome derangemen ſyſtem of the heavenly bodies; or it might

in a convulſion by which the earth alone was af-
However theſe things may be; its *immediate*
ras moſt probably—*the ſudden compoſition of* WA-
ither by the expanſion of HYDROGEN *and* OXYGEN
nbination out of a ſolid, ſeparate, ſimple ſtate,—or
condenſation of the ſame ſubſtances into WATER,
heir CALORIC *was abſtracted by the gazification of*
her matter,—perhaps DIAMOND, *which might exiſt in*
uantity, after the firſt ſolidification of matter, and
be now for its greater part rarefied into CARBONIC
never to be reſtored by nature to the ſtate of pure,
DIAMOND.

his means,—the *new forms of* WATER *and* CAR-
ACID,—*a ſufficient* DELUGE *would be eaſily pro-*
The carbonic acid, mingling with the water
aſtoniſhingly increaſe its bulk. CALORIC, *in the tran-*
through which it would neceſſarily paſs, in the pro-
of theſe phænomena, would act a mighty and im-
part towards the general convulſion of the Deluge.
t convulſion,—Animals might be driven from one re-
o another the moſt diſtant from it;—the exterior ſtrata
Earth might, even to a great depth, be deranged;
tever of thoſe mingled effects of the agency of fire
ater which ſtill confound the inveſtigation of phi-
ers,—had not been produced at the firſt formation of
rth,—might now be accompliſhed.

en that DELUGE ceaſed; its ceſſation muſt have
ed, in conſequence of *a decompoſition of the mingled*
R *and* CARBONIC ACID *by which it was occa-*

k-lime *is nothing but oxygen in a concrete ſtate.*

Nor

for are Potaſh or Soda, aught but particular
tions of this ſame principle of oxygen in concre
that decompoſition of water, and carbonic acid,
which was neceſſary to the deſiccation of the ſurfa
Globe,—the oxygen, moſt probably, furniſhed in c
with a part of the carbon, and with animal
depoſited in it,—thoſe STRATA *of* CALCARE
ter which are ſo extenſively diffuſed over th
The ſtrata of PIT-COAL *were now, for the f*
produced by the union of carbon from the carb
with a proportion of the oxygen from the decomp
the water, and another proportion of its hydro
TUMENS *were produced in various ſtrata, by th*
hydrogen from the water with carbon from the
acid. The proportion of hydrogen in water, is
compariſon with that of oxygen: *And, ther*
quantity of hydrogen fixed in bitumens, pit-coal
much ſmaller than that of the oxygen fixed in
rocks.

48.
Origin of
Calcareous
Rocks and
Pit-coal.

It is probable, that, the *Caloric* evolved whil
ſation of the Deluge, reſtored theſe matters to th
ſolidity, might be again ſtored up in the grand
of Electricity, from which it had been extricate
to act in thoſe mighty changes. The laws of ge
vitation, the attractions of the planets, the prog
ſeaſons, the conſtant movement of the Earth in
would do the reſt.

When the DELUGE ceaſed, the preſent a
was compoſed; the ſeas, the lakes, the rivers,
flow, as they have ever ſince done; the ſurface
pared to nouriſh vegetation, ſuch as has ſince gr

ere were ſtill preſerved abundant ſeeds of vegetables ; ce of animals had not been wholly deſtroyed. A etty convulſions have effected whatever conſider- hanges have ſince taken place.

Book I. Sect.

[illegible]

SECTION SECOND.

APPLICATION OF CHEMISTRY TO THE PHŒNOMENA OF VEGETATION, AND THE OPERATIONS OF AGRICULTURE.

Book IX. Sect. II.

1. Vegetables ſubject to chemical influence.

SINCE the Attractions of Chemiſtry have an influence ſo powerful and ſo univerſal, in the Earth, the Waters, and the Air; and ſince the Analyſis of VEGETABLES ultimately reſolves them into the chemical principles of Hydrogen, Carbon, Oxygen, and Azote, &c.; it is impoſſible but the phænomena of vegetation muſt, in a very great degree, depend upon chemical influences.

2. Their general growth and ſituation.

Vegetables are produced from ſeeds. They grow on the Earth, in the Air, at the bottom of the Ocean and other collections of water, on the ſurfaces of waters, paraſitical upon other vegetables, and in every conceivable variety of theſe principal circumſtances.

3. Definition of a vegetable.

Should it be aſked,—what is the preciſe definition of a vegetable? It is *an organized ſubſtance,—reproducible only by a peculiar ſort of generation,—augmentible in bulk, not ſimply by accretion, or by chemical combination, but by an enlargement of its organization,—in which a peculiar vitality co-operates with chemical, mechanical, and electrical influences, to produce the growth and ſalutary ſtate of the body,—and which after riſing into exiſtence, and paſſing through a certain ſeries of changes, is naturally deprived of its vitality, and diſſolved into its component material el*

4.
The generation of vegetables.

Theſe vegetables have this for the moſt general eaſily diſcernible fact, upon which we can eſtabliſh a ſyſtematic arrangement of them,—that they are are all reproduced from a peculiar ſort of generation. A tree is not ſo properly a ſingle individual, as a ſort of family of individuals. The flowers are the individuals. Theſe are male and female. There is an impregnation of the former by the energies of the latter. The impregnation quickly makes the florification give place to the formation of the ſeeds, grains, or fruits. In ſome, the impregnation or fecundation is ſufficiently apparent. Others ſeem to conceal it, and are called *Cryptogameous*. It was upon the obſervation of this grand law of generation in vegetables, that, after many imperfect attempts at a general claſſification of them, Linnæus at laſt ſucceeded in eſtabliſhing that ſyſtematic arrangement which botaniſts have hitherto found to be the moſt ſcientific, and the moſt commodious. He conſidered chiefly the flowers, examined the parts of each, diſtinguiſhed the male from the female, counted their relative numbers, remarked where the florification was not diſcernible; examined, after theſe, the next moſt general facts; thus eſtabliſhed claſſes, genera, ſpecies; and formed a general hiſtory of vegetables, which, whenever a plant can be found in florification, it is not difficult to compare with nature. As the flowers, however, form but a ſmall part of vegetable nature; much more is to be known; and one may be acquainted with the grand and general fact of the *Linnæan* ſyſtem in all its modifications, without poſſeſſing an adequate knowledge of vegetable nature in all its parts. The other general facts, are therefore, to be taken into conſideration; and upon theſe are founded the well-known natural orders in the

Botanical Syſtem. It is but for one ſhort period during each year of their exiſtence, that plants are in a ſtate of florification: And hence muſt ariſe a difficulty of diſtinguiſhing them from one another, at other times. For this reaſon, the celebrated JUSSIEU contrived that arrangement founded upon the internal ſtructure of the ſeeds, which botaniſts ſo much admire, and which, if it do not deſerve to ſuperſede the ſyſtem of Linnæus, is, however, inferior in beauty, utility, and ſcientific accuracy to the ſyſtem of Linnæus alone.

After due attention to thoſe general and moſt conſpicuous facts which are to enable us to diſcriminate between one plant and another; we may deſcend to the minutiæ of of organic and mechanical ſtructure, chemical compoſition, &c.

5. Their Organic ſtructure, &c.

As to ORGANIC ſtructure; all vegetables, when duely examined, preſent in all their parts, a *fibre* with a *tiſſue of cells* involving it. Wood, bark, all the parts of ligneous or of gramineous vegetables, are but collections of *fibre* and *cellular tiſſue*. In the ſtructure of trees, theſe are wrought into a number of remarkable organs. The BARK, the external covering of plants, conſiſts of—an *epidermis* or thin membrane, which forms the exterior part of the bark,—immediately under it, a *cellular coating*, the ſecond part of the bark, compoſed of veſicles and utricles, and connected by veſſels ſpreading out from it, with all the internal parts of the wood, even to the very pith,—beneath this cellular covering, an aſſemblage of laminæ, formed by the union of the veſſels for the ſecretion and diffuſion of the fluids through the plant, and conſtituting what are called—the *cortical coatings*. Under the bark, is the WOOD or LIGNEOUS TEXTURE, compoſed of fibres

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in the arrangement of concentric layers—intervoven and connected together—with a cellular tiſſue full of veſicles, which diminiſh towards the centre,—where, however, there exiſts an aſſemblage of them in the form of what is named the PITH.—The PITH ſeems thus to be only a collection of veſicles, the reſervoir of the ſuperabundant, elaborated nutritious matter. The LEAVES conſiſt, like the reſt, of *epidermis*, *cellular tiſſue*, and *fibre*. The BRANCHES are new trees implanted on the parent-ſtem, which ſerve to enlarge the quantity of ſurface which the whole plant expoſes to the atmoſphere. The ROOTS are branches, enlarging the quantity of ſurface that the plant expoſes to the contact of the Earth, and conſtituting, at the ſame time, its means of mechanical fixation and ſupport. In the PALMS, the fibres of the wood are applied, one beſide another, in a ſimple longitudinal arrangement. In other woods, they are arranged in circular layers, one without another, not perfectly concentric, but with a degree of eccentricity of which the cauſe is unknown. The GRASSES, fungi, &c. differ from the Ligneous vegetables, as containing a ſmaller proportion of *Ligneous Fibres*, The SEEDS and FLOWERS, as to minute, organic ſtructure, reſemble the wood and bark. Theſe are the SOLID PARTS of the vegetable. The fluid and gazeous parts are—the SAP, and the other *immediate Principles* of vegetables which have been formerly explained, &c. A part paſs through the plant, in a fluid ſtate. But, they are all perhaps refined to the tenuity of gas, before they are ultimately fixed in the ſolid organs of the plant. The juices, &c. are different in different plants. Some plants are only *annual* in their growth and decay. Others are more permanent; laſting for two years, for ſeveral years, or for an indefinite length of time, according to circumſtances. The root is often preſerved, and capable of giving birth to new plants, while the other parts periſh. The ſtems, the branches, the bulbs of the root, are capable of propagating the plant, as well as are the ſeeds. Earth, water, air, appear neceſſary to the nouriſhment of plants. They live and flouriſh, while ſupplied with theſe in due proportions They die without them. *Heat* or *Caloric*, and *Light* or *Lumen*, are equally neceſſary. The abſence of a due proportion of heat is fatal to vegetable life. Its preſence in a due proportion, enlivens all the organic energies of the vegetable. *Light* is continually acting upon vegetables; and no power can without its preſence, generate healthy, and vigorous vegetation. It is ſtill to be remembered, that, however various thoſe compounds which are called the immediate principles of vegetables; they are all ultimately reſolved into the four elements of oxygen, hydrogen, carbon, and azote,—of which four, azote does not exiſt in all vegetables, ſo generally as the reſt, and does not in almoſt any one, occur, in a proportion equally conſiderable.

6. Chemical Laws of Vegetation.

II. Now, *in what manner do the peculiar vitality, the chemical relations and dependencies, the mechanical circumſtances, of vegetables, and whatever other influences they are ſubject to,—accompliſh the whole of their vegetative growth, functions, and decline, with the formation of all thoſe peculiar chemical compounds which vegetables alone afford?*

7. Parts capable of Germination.

The ſeed, the ſhoot, the ſtem, the bulb from which vegetables are renewed,—contribute to the re-production of the individual,—ſolely, *as containing, in* *nd in the requiſite preſervation and organic arrangement, ll the eſſential parts of the vegetable form.* The ſeed is referable to all the other parts for the re-production of he vegetable ; becauſe it contains theſe eſſential parts in a atural preparation in which they are the moſt eaſily preſerved, the moſt conveniently diſſeminated, and, in ſuitable circumſtances, the moſt readily revived to vegetation ; becauſe, by means of the ſeeds, vegetables are univerſally re-produced,—but of ſome, we know not to accompliſh the re-production by other means.

8, First changes in Germination.

A ſort of *ſaccharine fermentation,*—if we may, without impropriety, employ the term,—is neceſſary to prepare the *ſeed* for the revival of the energies of vegetable vitality. Whatever *Azote* is in it, muſt be ſeparated and evolved, its hydrogen, carbon, and oxygen muſt be brought together in thoſe proportions and that union in which they form ſaccharine matter. Whether a ſimilar change take place in the ſhoot or ſtem, in order to the re-production of the vegetable, is perhaps leſs certain. But, it is moſt likely, that,—when the ſtem or ſhoot has already ſuffered any material, chemical change of its parts,—vegetaion cannot be from it renewed : Where it is ſtill fit for the enewal of vegetation,—the ſaccharine preparation may ot be neceſſary in it.

9, Commencement of Vegetative Life.

At the moment when the matter of the ſeed, or other ganized portion, has received the neceſſary chemical preparation,—the *peculiar energies of vegetable life,*—are, by that myſterious law of nature we know not, renewed in *The peculiar energy of* VEGETATIVE LIFE, *conſiſts its converting into peculiar compounds, diſtributing in a culiar mechanical arrangement, and employing for the geral enlargement and ſupport of its organic ſtructure,—*

whatever ſuitable matters are preſented to its proper exterior organs,—and eſpecially in its combining to one common end—laws, chemical, electrical, mechanical, which could not otherwiſe, act together in harmonious union. Where chemical or mechanical means are employed to hinder this energy from ever commencing to act upon the ſeed which the *ſaccharizing proceſs* has prepared for it; the ſeed ſoon haſtens to putrefaction and final diſſolution,—if it be not brought into thoſe circumſtances by which the vinous fermentation is to be excited in its ſaccharine parts. When *Vegetable Vitality* commences, the progreſs towards diſſolution ceaſes. That part of the ſeed may decay, out of which the *ſaccharine matter* has been extricated. The Saccharine matter itſelf becomes the living embryo of the new vegetable.

16. irſt Ener- ies of Vegetative Life.

After *Vegetable Life* or *Irritability* has thus commenced, its firſt energy is exerted in receiving from the *Earth*, in which the embryo is imbedded, the impulſe of *water* impregnated with various ſoluble or ſuſpendible ſubſtances; *which* its exterior organs refine to gas, as they convert it into nouriſhment. It is neceſſarily from the *Earth*, that the embryo vegetable takes in its firſt nouriſhment: for, it is imbedded in the ſoil;—in the air, the fluctuation of parts, and the variation of temperature are too inceſſant to afford that ſlow digeſtive heat, and that long exterior application of the nutritive matter, without which the firſt excitement of vegetable irritability might—not ſo eaſily take place;—only at the ſurface of the *Earth*, is there to be found a ſufficient accumulation of that matter from which is evolved—the proper pabulum of vegetable life. When vegetables ſpring up in water, there muſt be a ſort of ſtagnant fixation of the water, whi nbles the ſteadineſs of a baſis of *Earth*. Vegetable life never renovated, while the ſeed floats about in air.

11. Vital action of the *Epidermis*.

The *Epidermis* of the *Bark*, neceſſarily acts to vegeta- es, as the *Mouth* or organ for the ſelection and introſuſ- ption of food. It is exceedingly fine and cloſe in its echanical texture ; for, it is perhaps deſtined to perform ot a chemical, but a mechanical part ; and that mecha- iſm muſt, of courſe, be extremely fine, which ſhall, in he relative ſituation of the epidermis of the bark, exclude ery matter that might injure the interior organization of he vegetable.

12. Chemical and Vital action of the Cellular Tiſſue of the Bark.

The *Cellular tiſſue* of the *Bark*, is the firſt receptacle, nd the reſervoir of the food taken in by the *Epidermis*. n its *veſicles* and *utricles*, is that food depoſited for digeſ- on and nutritive diſtribution. In them, begins the che- ical proceſs by which the living vegetable digeſts its food to a proper addition to the ſubſtance of its organs. The echanical relations and powers of the organs and of the d, are made to co-operate with thoſe which are che- ical. In its paſſing from the utricles and veſicles of the ular *tiſſue*, through the organs of the *cortical coating*,— e SAP, the general *chyle* or *blood* of the plant, is com- ely elaborated. By this elaboration, thoſe chemical nciples are ſelected which can alone contribute to the enance of vegetable life ; and they are mixed together at one of the *Immediate Principles* of Vegetables, ch is named *Mucilage*.

13. *Mucilage*, the chyle of Plants.

This *Mucilage* contains oxygen, carbon, hydrogen, and e, the chemical elements of all vegetable ſubſtance, in combination in which they are the fitteſt to be diſtri- d for the ſalutary ſupport of the particular vegetable

within

within which, the mucilage is found. *Azote* exiſts
mucilage in a proportion ſmaller than that of its ot
gredients. Nor is the oxygen, uſually, ſo copious
hydrogen and the carbon.

14.
Phyſiology
of Vegeta-
tion.

The mucilage thus prepared, is carried into the
ture of the wood; and is conveyed through it, by
culation, or perhaps ſome different movement; of
the ſecret ratio has not yet been diſcovered; but
perhaps extends only in its fineſt gazeous elaborat
the general ſyſtem of the tree or whole plant. The
tiſſue of the wood ſeems to form its circulating and
dular ſyſtem. The fibres reſemble the *bones*—perh
leſs than the fleſh—of the animal body. The PITH
it ſhould ſeem, a reſervatory ſtore of the finely elab
nouriſhment of the plant; deſtined to reſtore its co
for the ſupport of the vegetable life, when there is
ciency of nouriſhment from without; as well as
out, at the proper ſeaſon into the flowers, and all th
parts of fructification. The circulation within the
is performed, partly by *liquid*, partly by *gazeous* ſub
The veſſels vary in direction and tenuity,—as it is a
a fluid which they are deſtined to convey. The c
tion extends as well to all the parts of the pith, the
the fruits, and the bark, as to the wood. Continu
cretions of thoſe which are called the *proper juices*
throughout the plant. Juſt as the ſemen, the tears
eyes, the cerumen in the ears, &c. are ſeparated fro
human blood; ſo are the various principles of each
which differ in their nature from the common ſap, ſ
from that ſap in its courſe of internal motion, by
ceſs in which *vegetation* combines the agency of th

mical, with that of the chemical, qualities of theſe
atters. Theſe *ſecretions* conſiſt—*partly* of *excrement*, or
atter, which, after performing its part in the vegetative
ctions, is to be periodically, thrown out of the ſyſtem;—
rtly of *matters* requiſite to the re-production, or to the per-
nent, ſalutary exiſtence of the plant. That matter which
requiſite to the permanent health of the plant—accord-
g to its particular nature,—is continually fixed in its
d ſubſtance, after the proper elaboration and diſtribu-
. The *excrement*, in the healthy ſtate of the plant is,
bably, thrown off, only in a gazeous form.

15. Temperature of Vegetation.

Heat or *Caloric* is ſenſible to the human hand, and to
r inſtruments, only while it paſſes out of one combina-
into another. In the ordinary growth of plants, ſo
y fixations of liquids and gaſes into ſolids, are conſtantly
g on, that they cannot but have within them *a ſenſible*
, ſuperior, in its ordinary ſtate, to the colder temperatures.
the other hand, as their excretions are made only in gas;
requiring much caloric to its expanſion, muſt conti-
y carry off ſo much as to prevent any exceſſive accu-
ion of *heat* within the living vegetable. But, while
caloric taken in with the food of the plant, and ſet at
y by the fixation of the due proportion of its fluids,—
remain in a juſt equality to that which is carried off by
eous ſecretions; ſo long muſt the plant retain its na-
temperature. The tranſitions within it, of fluids into
, and of ſolids again into fluids, are the immediate
of its ſenſible heat. The temperature of plants,
of conſiderable variations; and, within a certain
—the warmer the temperature, ſo much the more vi-
will be the growth of the plant,—provided that the
ſe of heat be accompanied with an increaſed ſup-

ply

within which, the mucilage [illegible] When the
mucilage in a proportion [illegible] than that
gredients. Nor is the [illegible] eaſily advance;
hydrogen and the carbon [illegible] into gaſes, for the

14. Phyſiology of Vegetation.

The mucilage thus [illegible] growth of the plant
ture of the wood; and [illegible] its vitality may not
culation, or perhaps [illegible] in their character,
the ſecret ratio has [illegible] animals which ſleep during
perhaps extends [illegible] the ſtate of the atmoſphere
the general ſyſtem [illegible] which their liquid and
tiſſue of the wo[illegible] natural condition; the plant
dular ſyſtem. [illegible] not grow. When the genial
leſs than the [illegible] ns; the temperature of
it ſhould ſeem [illegible] —By combining with this
nouriſhment [illegible] —the obſervation of the
for the ſup[illegible] the firſt ſprouting of the bud,
ciency of [illegible] and the fall of the fruit,—
out, at th[illegible] underſtand the cauſes of the
parts of [illegible] in trees. In Spring, Summer,
is perfor[illegible] of external nature ſupplies the
The [illegible] nouriſhment. The genial heat
a [illegible] the greateſt livelineſs of energy to
tio[illegible] It enlarges its wood and bark
th[illegible] leaves, and produces ſeeds for
[illegible] ſpecies. This growth gives it,
[illegible] a larger proportion of nouriſhment,
[illegible] ceived. But, the advantages which
[illegible] ment, are not, at firſt, equal to the
[illegible] Its new parts are not, at firſt, ſufficie
[illegible] in its growth, with the old. The
[illegible] aſſimilated with theſe, before the whole
[illegible] its functions with full health and vigo

ment of its veſſels, naturally promote this
ſlowing of the SAP; becauſe *when the ru*
veſſels in the bark; and the ſlow of the SA
ring of this bark has taken place,—it is nec
ring immediately above it ſhould from the
ſimilitude of circumſtances, experience the ſa
veſſels, and ſlow of SAP, *ſooner than any m*
The laws of *Hydroſtatics*, as well as thoſ
will be found to have an influence in regul
and there are many minuter circumſtances
expoſure, to be attended to, while we atter
its ratio. The final decay of the annual
courſe of every ſucceeding year, the differ
the lives of the graſſes and of the ligneous
culiarities of foliage in the evergreens, and
of plants which, in a foreign climate, ſurp
ing properties more ſuitable to that of wh
indigenous,—are, all, to be explained by
of the general principles which have been
the peculiar circumſtances of each. *Elec*
to be regarded as a cauſe of a portion of the

chemical principles which vegetables take in as
ment,—the forms in which whatever of theſe
e retained, is depoſited in the vegetable ſubſtance,—
e elementary nature of the ſecretions which they
out,—deſerve to be, yet a little more particularly
ered.

18. Chemical phænomena of Vegetation.

ultimate reſolution of Vegetables by chemical
s, affords, as we have found, only, *hydrogen*, *car-*
ygen, *azote*, with perhaps, in moſt caſes *potaſh*, or
s their proper principles, and occaſional contami-
of other matters in ſmall proportion. *Earth*,
d *Water*, can alone afford theſe principles; for, no-
lfe is to be obtained as a pabulum for their growth.
ks, none of the ſimple earths is ever known, alone,
er and ſupport this growth: No ſalt excluſively em-
, will more effectually accompliſh this end.
will, almoſt, alone, in its ordinary ſtate, ſuffici-
ed vegetable life: *Air*, too, powerfully nouriſhes
ion: *Heat* and *Light* are neceſſary to its ſalutary
. In *comminution* and in *mixtures*, the different
re ſeen to nouriſh vegetables,—rather, however,
ly than directly as food,—if we except only
Oils, bitumens, almoſt all ſaline and combuſtible
es *in mixture*, if not alone, are capable of aiding
wth of plants. The want of water and of air,
s heat, drowning moiſture, chilling, freezing cold,
t of ſufficient ſupport and covering at the root,
even of any one of thoſe things which are in due
on, the moſt ſalutary,—dwarfs or deſtroys them.
uſt not be buried in denſe impenetrable earth:
uſt not be excluded from acceſs of air: They
t be hidden from the light of heaven. In gas-
azote,

in which they grow, be never too ſandy, ſively argillaceous or ſiliceous, never—even calcareous. Different gaſes have been ob hale, at different times, and in different ſit the exterior ſurfaces of plants. In the lig been found to exhale gas-oxygen; in the da been obſerved to give out gas-azote: As have varied; the nature of the gaſes they varied likewiſe, to the great aſtoniſhmen and diſagreement in opinion, of philoſophe

19. Secret relations of theſe phænomena.

The more ſecret relations and tranſactio theſe phænomena depend, may be thus exp inhale nouriſhment—only in the forms o *gazeous* ſolutions. The *roots* take in wha ment they receive—chiefly in water, and i with water, and other liquid ſolutions. branches, flowers, fruits, and leaves take i aqueous nouriſhment; but receive a muc portion of that which they inhale, in a gaz is in general, ſalutary for plants, to recei ment, rather in a gazeous than in an becauſe what they take in the form moſt part, eaſier to be digeſted into wh

ly ſorts of food which plants can take in. All ſoils, all
ts, all ſituations, in which they grow and thrive, muſt af-
rd theſe elementary pabula. Where theſe are to be ob-
ined, in ſufficient quantity ; plants take in, over all their
rfaces, by the energy exerted in the epidermis of the
rk,—preciſely that due proportion of each element,
hich is requiſite to their healthful ſupport, according to
s reſpective nature of every different plant. The roots
f very many plants, comprehend a proportion of exterior
rface, little leſs conſiderable, than that which they ex-
e to the external air: And, therefore, in every fertile
, no ſmall proportion of the food of ſuch plants is taken
—at leaſt through the medium—of the earth. Soils
rding azote, hydrogen, and carbon almoſt in a ſepa-
ſtate, are eminently fertile and produce plants of very
riant growth ; becauſe ſuch ſoils ſupply in great
ndance, the elements of vegetable ſubſtance. Water
eminently nutritious to vegetables, partly becauſe it is
vehicle for all the other nouriſhment which they take
at the roots, partly becauſe it is, even undecompounded,
conſiderable article of their food, partly becauſe its de-
poſition at the Epidermis, affords hydrogen and oxygen,
ements which enter, largely, into their functions and
ructure. Oxygen conſtitutes a neceſſary part among
la of vegetative life, in a proportion perhaps not
larger than that in which it has been diſcovered to
ually fixed in their ſubſtance. It is neceſſary to
many internal compoſitions by which the matter of
ſolid parts is finally elaborated. It is, perhaps, fixed
ſolid form, in the potaſh, the ſoda, and the lime
ch plants are well known to afford. The manner
which calcareous ſoils exerciſe an influence ſo emi-

[illegible] ſatisfactorily explai
[illegible] certain circumſtances,-
[illegible] oxygen—of which it is
[illegible] of vegetable life, exerted
[illegible] this form, paſſing in
[illegible] the vegetable,—and
[illegible] or fixed in the ſolid
[illegible] three ſtates of lime,
[illegible] light and heat is often
[illegible] energies of the epiderm
[illegible] ions, and making thoſe
[illegible] are neceſſary to its taking
[illegible] vegetative energies are con
[illegible] ternal heat of plants in ge
[illegible] to 15° above that of th
[illegible] its mean temperature. Veg
[illegible] the more ſenſible parts o
[illegible] acted upon by light and hea
[illegible] ances, the energy of the epi
[illegible] takes in food with great avi
[illegible] atmoſpherical air, only thoſ
[illegible] for its ſuſtenance,—takes,
[illegible] oxygen, than of carbon and azot
[illegible] augment the oxygenation of
[illegible] In the dark, vegetables
[illegible] this ſtate, the energies of the e
[illegible] ficiently excited, to take in much
[illegible] at this time, give out an excre
[illegible] too, the proportion of oxygen i
[illegible] ſmaller in the dark,—and, therefor
[illegible] to be rejected by plants growing in
[illegible] There is perhaps, too, a certain fix

ght in vegetables, which is effected by the energies of the epidermis, and accompliſhed not without a decompoſition of gas oxygen in which there is oxygen ſet at liberty, to accumulate in the atmoſpheric air from which the light has been withdrawn. The *leaves*, being far the fineſt parts of plants, and enveloping the ſmalleſt proportion of ſolid ſubſtance, taken in, as it ſhould ſeem, little nutriment that is not reduced on their ſurface to the gazeous form. The roots, probably, take in their nouriſhment, rather in water alone. The bark of the trunk and branches, certainly does not, in old trees, take in ſo much of its aliment in gas, as do the leaves. The carbon of vegetables, is obtained, no doubt, from the carbonic acid—of the atmoſphere—of the carbonic ſalts of the ſoil,—and of thoſe in moſt manures—eſpecially in calcareous manures. Being ſooner fixed in the ſolid ſubſtance of vegetables, than azote or oxygen, or perhaps even hydrogen; it is much more ſcantily—perhaps ſcarcely at all, thrown off by perſpiration: And therefore, a ſmaller proportion of it, in compariſon, will be adequate to the purpoſes of ſalutary vegetation. Water, oils, &c. abundantly ſupply the hydrogen of vegetables. When vegetable life periſhes, the vegetable ſubſtance is more or leſs entirely diſſolved by the reſolution of its fluid and putrefiable parts into gas.

III. Agriculture cannot be exerciſed with any tolerable ſkill, without a knowledge of the influence of the chemical laws of Nature upon vegetation. In the examination of ſoils, and in the whole ſeries of ſubſequent operations, the directions of Chemiſtry are indiſpenſibly neceſſary. 20. Chemical Agriculture.

1. Thoſe soils, are, neceſſarily, *the beſt*, that contain the greateſt ſtore of thoſe principles which conſtitute 21. Soils.

pabula of Vegetation. Such are Calcareous Soils in which *oxygen* is depoſited in concretion, and in which *carbon* and *azote* often exiſt in union with the oxygen.

22. Calcareous Soils.

Soils formed from the *decompoſition of animal and vegetable matters*, are, likewiſe, in their nature eminently favourable to vegetation: For they contain *hydrogen* and carbon combined in an oleaginous form, ſometimes in a compoſition approaching to the bituminous,—together with remains of animals and vegetables, as yet only tending to decompoſition,—with various ſalts, ſuch as naturally reſult from the decompoſition of animal bodies,—water,—earth,—and gazeous principles in continual evolution.

23. Loams or mixed Soils.

Next after theſe, in the order of chemical fitneſs, are thoſe *mixed ſoils*, in which calcareous matter, oleaginous matter, and water, are intermingled with aluminous, ſiliceous, and magneſian earths, with iron, and with various ſaline ſubſtances, as well as with that imperfect comminution of ſiliceous and aluminous rocks which we call ſand or gravel, and with ſome undecayed parts of vegetables. This mixture, is, moſt commonly, the reſult of long working with the plough. It is called by the farmers, a LOAM. It exiſts in many different modifications, according as the proportion of the ingredients, is varied in the mixture. Some of theſe modifications of this Loam, though not, in reality poſſeſſing ſo much of the pabulum of vegetable life, are, however, *more conveniently* fertile,—on account of the *mechanical* nature of their mixture,—than the richer ſoils of the former claſs.

24. Clays.

The *third ſort* of *ſoils*, in the order of fertility, are thoſe which are commonly called Clays. They contain aluminous earth in a predominant proportion, a proportion of ſiliceous earth, often more or leſs of calcareous

Earth,

h, with iron, and uſually ſome ſmall mixture of the ins of vegetables. Water is diffuſed through them in r fertile ſtate. The water, the lime, the vegetable matter ch they contain, and their tendency to form new binations by the attraction of gaſes from the atmoſ- re, are the cauſes of their fertility. Chemiſtry, aſcer- ing in what proportion, theſe ingredients reſpectively t in *Clays*, thus determines the *ſpecific fertility* of l.

25. Sands and Gravels.

hoſe which are called SANDY and GRAVELLY SOILS, be ranked after the Clays. SAND is *Stone* commi- d into ſmall portions, evidently by attrition in water: AVEL is *Stone* cruſhed down in the ſame manner, h little or no intervention of water. *Siliceous Sand* *Gravel* is incapable of nouriſhing any tolerable vege- n; becauſe it is not, of itſelf, decompoſable into mat- which the functions of vegetative life can convert into riſhment for vegetables; and becauſe it does not rly attract into neutral combination with it, any of e other ſubſtances, by which vegetable life is ſuſtained. *minous Sand* is more fertile; for it tends continually to ompoſition, and to attract into combination, ſaline ſtances which afford nouriſhment to vegetables. The fertile of all ſand or gravel, is the *calcareous*; for its poſition affords one of the immediate elements of tables,—it uſually contains others of theſe elements in poſition with it,—and it attracts them eagerly from ſurrounding air and waters. A mixture of theſe s in certain proportions, is apt to afford a better re- to the cares of tillage, than any one of them, ſepa- ly. In ſituations, in which there is a ſufficient, yet overflowing ſupply of water, this mixture of *ſands* or *gravels*, is, in a particular manner, likely to diſplay extraordinary fertility: for, it forms a ſoil peculiarly fitted to imbibe and to circulate moiſture for the ſupport of vegetation, without detaining it in that ſtagnant ſtate in which it might check the growth of vegetables, or cauſe them to ſhoot up with a diſeaſed luxuriance.

26. Peat Earth. The only other ſpecies of *ſoil*, worthy of being, here, particularly diſcriminated, *is that of bogs and moraſſes*, in which *bitumens*, *carbon*, and the unputrefied remains of vegetables, with the acids formed from wood and bark, exiſt together, with a conſiderable affuſion of ſtagnant water. This ſort of ſoil is naturally incapable of producing any but aqueous plants and certain ligneous vegetables, which act upon it with a very ſtrong energy of vegetation, and are capable of deriving a large proportion of their nutriment from the gaſes of the atmoſphere. Tracts of ground, covered with this ſoil, uſually abound in ſprings of water, which diffuſe it in quantity too great for the ſubſiſtence of any but aqueous vegetables. Theſe ſprings are to be drained off, by trenches conducting from them to the lower extremity of the field. The whole vegetation of the moraſs is, thus, to be, firſt, deſtroyed. Then, the working of tillage, and the application of quick-lime, or other oxygenating manures, will reduce the whole ſtratum of PEAT-EARTH or mixed carbon, bitumen, vegetable acids, and undecayed vegetables, into a ſtate, in which it will afford the richeſt and moſt abundant ſuſtenance to vegetation. In its natural ſtate, the *ſoil of moraſſes* may be regarded as barren. It is, however, in the higheſt degree, ſuſceptible of artificial fertilization.

27. Manures.

27. Where the moſt fertile of theſe Soils, exiſt in the beſt proportion of their reſpective ingredients; MANURES are perhaps unneceſſary. But, ſuch happy ſoils are exceedingly rare in theſe northern and long inhabited regions. Hence, it becomes continually requiſite to add to grounds on which we deſire to cultivate peculiar vegetables, *certain matters, the admixture of which with the ſoil, ſhall render it as rich as poſſible, in the proper pabula of vegetation.* Theſe matters are called MANURES. Every different ſoil, according to the diverſity of its nature and compoſition, requires a peculiar MANURE, or at leaſt a greater or a ſmaller proportion of the ſame common MANURE.

28. Calcareous Manures.

For moſt ſoils, *Quick-lime, Carbonate of Lime*, or the mixture of *Carbonate of Lime*, in MARLES, with ſiliceous and aluminous clays,—form the beſt MANURES. *Sea-ſhells* and *ſleech*, as being an impure carbonate of lime, are not leſs valuable than marles, in the character of a calcareous manure. For the fertilization of ſtrata of peat-earth, nothing is equal to *quick-lime*. It diſſolves by its oxygenous energy, the preſerved vegetables and the bituminous compounds in that earth, attracts the carbon in part, into a carbonaceous compound with itſelf, even abſorbs into a ſimilar combination, no ſmall portion of the ſuperfluous water, and by all theſe changes, produces, at laſt, a mixture of carbon, hydrogen, oxygen—of almoſt all poſſible mixtures in ſoil, the moſt fertile. There is, alſo, a ſort of deep, ſour, ſtiff ſoil, a mixture of clay with the undecayed roots of coarſe vegetables, and with a portion of matter from the decompoſition of vegetables, often accompanied with an exceſs of moiſture. For this ſoil, alſo, quick-lime is the fitteſt *manure*.—For *clays* which na-

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turally contain little or no calcareous earth, the *carbonates of lime* in ſand or gravel, will form a manure of conſiderable efficacy. It will do ſtill better, if there be joined to it, an addition of putrefied vegetable matters. On *gravelly* ſoils, in general, where the ſoil is not too thin, and too deſtitute of the matter from the decompoſition of vegetables, *carbonates of lime* may be moſt advantageouſly employed as *manures*. *Sulphate of Lime* or gypſum, and in general all calcareous ſalts, are eminently fertilizing. The neutral ſalts of lime, are more uſeful than quick-lime, for the fertilization of the beſt ſoils,—becauſe the energies of *pure quick lime* or *pure concrete oxygen*, when applied directly and in their full activity, to the organs of living vegetables, operate with a force tending to deſtroy, juſt as the inſpiration and reſpiration of unmixed gas-oxygen for a whole day, would, moſt probably, prove fatal to animal life. Carbonates of lime are, in proper caſes, valuable as manures, becauſe they are ſtores—not only of oxygen, but alſo of *carbon* in that ſtate in which it is the moſt eaſily converted into food for vegetables. The concrete oxygen of lime, appears to be *gazifiable* by the functions of vegetable life alone, never by thoſe of animal life. Oxygen, again, is thus *concreſcible*—chiefly by the functions of animal life,—as in the formation of the bones of animals in general, and of the ſhells of ſhell-fiſhes.

29. Dung. For all the *lighter ſoils*, eſpecially for thoſe which lie on a calcareous bottom, the beſt MANURES are thoſe mixtures of *ſalts from the bodies of animals,—putreſcent vegetables—and water*, which our common dunghills afford. Theſe contain hydrogen and carbon in the form of oils, often potaſh in union with the azote and oxygen of

phoſphoric and ſulphuric ſalts, with portions of ſili- a, aluminous, and even calcareous earths, and with a iderable quantity of vegetable ſubſtances as yet only ing to putrefactive decompoſition. None of all theſe ers, exiſts, in the dung, in any very refractory combi- n. They are, therefore, eaſily diſſolved, to afford ſtence to the roots of vegetables. They are in a con- n, too, in which they readily admit of that mechani- dmixture with the ſoil, which is neceſſary to their or diffuſion through its exterior layers. For alu- us ſoils with a mixture of ſilice, this manure is ad- bly fertilizing. Wherever you have any conſiderable ity of earth in ſufficient comminution, without a proportion in it, of matter that has paſſed through laboration of vegetative or animal organs; you will ll to lay on matter from the dunghills.

30. Compoſt of Quicklime with Peat-Earth, &c.

here are caſes, in which the *ſoil* is ſo exceedingly and ſhallow, as to want both additional earth and re. For land of this nature, the beſt fertilizer is *a* *re of* QUICK-LIME *with* PEAT-EARTH. They t to be, for ſome time, digeſted together, before being n the ground. When they are laid on the ground, ſt immediately before the ſpreading out,—it may be r to add a proportion of dung, the vegetable part of h, is well diſſolved.

31. Nitrous Salts.

itrous Salts are continually formed, wherever animal es are expoſed to the oxygen of the atmoſphere,— wherever calcareous matters exiſt in ſituations in h they may attract azote from the atmoſphere. But, alts containing oxygen and azote, two of the ele- s of vegetable bodies, and probably, alſo, a third r that is capable of furniſhing pabulum to vegeta- tion,—

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tion,—are, hence, eminently fitted for beneficial u
manures. Therefore, the ſweepings from the ſt
horſes, and from old walls, the ruins of old houſes,
a manure of admirably fertilizing qualities, on a
of its *nitrous ſalt.*—*Sea-weeds*, being very co
charged with ſoda and various muriatic, ſulfur
magneſian ſalts,—all a[illegible]ording oxygen, and perha
of the other vegetabl[illegible]lements, in abundance, are
account, adapted to operate with an extraordinar
lizing energy. But, the matters which their dec
tion affords, either enter into the compoſition of t
vegetables which they are applied to ſupport, or e
away with great rapidity into a gazeous ſtate.
form, therefore, an active, not a durable ma
Almoſt all the combinations of the acids with th
and alkalis, give out,—in mixture with ſoil,—in
with the roots of vegetables,—and in expoſure to
tion of the atmoſphere,—one or more of the ele
pabula of vegetables. Hence, as manures, they m
very many caſes, be found admirably uſeful, if the
not, by much too expenſive.

32. Water.

Of all Manures, there is none comparable to w
—for great and univerſal utility. Its compoſition
drogen and oxygen, renders it directly and pow
nutritive to plants. It has the advantage of con
theſe principles, in the proportions in which they
be the moſt happily prepared for vegetative digeſti
enters, even undecompoſed, as an aliment, into
ganization of vegetables. Its decompoſition is con
effected with the aid of Light and Heat, at the ep
of the bark of thoſe vegetables with which it con
contact. It is the only vehicle by

can be conveyed from ſolid bodies, to plants. And whatever gazeous food the roots of vegetables receive, is preſented to them through the intermediation of water. For theſe reaſons, it is of infinite importance,—to have ſuch a mixture of ſoil and manures, as ſhall the beſt imbibe moiſture, and the moſt equably diffuſe it.—*Water* in too large proportions, is unfavourable to the healthy growth of our common graſſes and grain-bearing plants. It is apt to make them ſhoot up with exceſſive green luxuriance, ſimilar to that which takes place in animal life, when a young animal becomes enormouſly and oppreſſively fat; or, if in a ſtill greater exceſs,—it entirely arreſts their growth, makes them incapable of the vital functions, and effects a putrid decompoſition of their organization. In ſituations where there is a mixture of plants of various characters,—this exceſſive affuſion of water tends to deſtroy thoſe plants which are the moſt eaſily injured by its exceſs,—and on the other hand to nouriſh thoſe to which the preſence of a larger proportion of *water* is ſalutary,—till the former claſs are gradually exterminated,—and none but the latter continue to grow on this over-watered ſpot. It is thus, that, in grounds full of ſprings,—ruſhes, moſſes, and aqueous plants, continually ſhoot up, in ſpite of every care, over the ſurface,—and choak ſuch as delight in a drier ſoil.—To all the plants of ordinary crop in this country,—it is the conſtant, gentle affuſion of water, diſperſing itſelf in all directions, never ſtagnant, never running with great impetuoſity of current, ſcarcely ever ceaſing to flow, more copiouſly applied in the light and under the heat of the Sun, than in the dark,—which operates with the beſt efficacy, as a manure. Periſhing by decompoſition, doing miſchief by its ſtagnation, or running, or evaporating,—

33. When hurtful.

Water

where the ſoil is dry, ſtiff, yet not without
depth,—there water may be—perhaps with
vantage, conducted over it in ſtreamlets
themſelves in the field, even for ſome time, b
is ſown. Graſſes, however, of perennial
other plants of ſimilar duration, may be grea
by water conducted near them in ſtream
time in the ſeaſon when the temperature o
34. How the moſt uſeful. prevents them from receiving much nouriſh
citement to their vegetative energies, from th
above the ſurface: For, their whole nutritio
be taken in by the roots; their vegetative e
retired, as it were, for a time, into the root
at once ſupplies food, where, alone, it can be
received,—and acts as a powerful ſtimulus,
activity of the vegetable functions. No arti
applying water as a manure, can equal tha
ſending it down in ſhowers and dews, d
miſts, making it alternately to riſe in vapour
ſcend in rains, conſuming and evaporating it
tation of Spring and Summer, then, in
Winter reſtoring it in rains, hails, ſnows

. The form of your plough, your ſpade, your hoe, harrow, muſt be modelled upon mechanical conſide- s. The mode of yoking your ploughs and harrows, ımber of the cattle you employ to drag them, the er in which to apply the plough, the hoe, the ſpade, arrow to penetrate and break the earth, are, alſo, to ulated by a reſpect to the relations of gravity and of aniſm. But, in other reſpects, you will not work ground advantageouſly, without a continual reſpect mical principles.

our artificial attempts to produce and direct vegeta- —we open the earth by *digging* or *plowing*;—becauſe communication between the ſoil, water, and air, is be otherwiſe obtained;—and becauſe we could not wiſe, procure that mixture, and thoſe tendencies to decompoſition, which are eſſentially requiſite to r vegetation.

are careful not to penetrate *too deep* into an un- , ſiliceous or argillaceous ſoil,—becauſe, in doing we ſhould but bury the ſuperficial earth which being properly mixed character poſſeſſes a reaſonable pro- n of fertility,—under a matter that is, by itſelf, tely barren. We plow deep into ſoils which are by chemical compoſition, more fertile; becauſe it is to bring all the fertile matter of the ſoil, as much ible, into due activity.

form our *ridges* and *furrows*, ſo as to favour the ation, and to prevent the ſtagnation, of water, on nt of the chemical tendency which water has,— ſtate, to nouriſh vegetation,—in another, to make uiſh.

We

ſtore that open ſtate of the ſoil, which natura
and the compoſitions and decompoſitions a
tend conſtantly to deſtroy,—but, without whic
cannot be eaſily and vigorouſly carried on ;—
the growth of thoſe native vegetables whi
Weeds, is to be checked, in order to promot
of ſuch as are to form our crop,—and cannot
checked, without burying them from that a
Sun's light and heat, which is indiſpenſibly
the due excitement of the vegetable ene
upper parts.

All the other proceſſes of *Tillage*, as v
will be injudiciouſly conducted, unleſs due r
in them, as well to the chemical relations c
the plants, as to mere mechanical agency.

36. Choice and and preparation of vegetable ſeeds.

4. In the choice and the preparation of
of chemical knowledge is eſſentially neceſſar
miſtry that teaches us,—what plant beſt ſuit
ſoil, climate, and expoſure,—and whether it
advantageous—to ſow or to plant,—to ſow o
or that time in the ſeaſon,—to ſow our gra
ſtate or with a previous moiſtening which

ıe hopes of the coming crop, and which is
it a fine carbonaceous matter,—perhaps only a
:retion from the original ſeed,—perhaps ſome
ınimalculæ generated originally by the depo-
nperceptibly ſmall eggs, and inceſſantly renew-
generations with the renewal of the crop, till
y the uſe of proper ſaline ſolution, deſtroyed.—
teaches to change ſeeds between ſituations,
ſoils, climates of conſiderably different character,
g us, that each ſoil, ſituation, expoſure, or cli-
a tendency to favour ſome particular exceſs
of this or that principle of the vegetable,—
paucity to be corrected only by uſing ſeeds in
exceſs or paucity are contrary to thoſe which
as a tendency to encourage. It is by chemical
tion, too, that we diſtinguiſh, how a well-ri-
ge, pure ſeed is the fitteſt to afford a reproduc-
plant,—becauſe it enters the moſt advantage-
that ſaccharine fermentation in which vegetable
commencement.

37. Growth of Vegetables.

le our *corn* and *graſſes* ſpring, the appearances
it, are beſt to be judged of, by chemical princi-
they ſhoot up with an unnatural luxuriance?
ſuperabundance of water undecompounded, of
of carbon, perhaps alſo of azote,—a deficiency
, and of the incitement of light and heat. Do
dwarfiſh, and haſten before attaining vigorous
h, into a ſtate of ripeneſs? They are, then, too
pplied with water and with carbon, or perhaps,
r only. When dung, water, carbonate of lime,
anting,—we ſee plants,—if the want be long and
wither and die away:—This is—becauſe they
are

avidity. When grains have [illegible]
growth ; they then in ripening [illegible]
before, of the preſence of light and heat, t
engage from their aliment and their ſubſtan
of oxygen ;—becauſe ripening is, *in part*, a
genating proceſs, accompliſhed by the ve
ons. Froſt, by its tendency to extract and
and gaſes, ſerving to carry off the exce
matter, operates with a power ſomewhat
natural proceſs of maturation with the ai
heat, but haſtens that proceſs in a manner h
to the laſt perfection of ripening.

38.
Drying and preſerving of Corn.

6. When corn is cut down, chemiſtry
farmer in the *drying* and the *preſerving*
drying is neceſſary to drive off that undec
which remains in the ears and the ſtalks,
ſince the energy of the vegetative functio
would quickly effect in it a change in the o
ciples, and would thus conduct it, gradua
tire decompoſition of almoſt all its ſtruc
fermentation. In the preſervation of you

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e *grains*,—that, and the *extractive juice* are to be
drying it on the *Kiln*,—before carrying it to be
the mill. After it is ground into flower or meal,
ing for bread, and all the other proceſſes to fit
d, are of a chemical character. Fruits, roots
other vegetable production are, in like manner,
erved and prepared by chemical Arts.

s that chemiſtry furniſhes its aid in Rural Œco-

SECTION THIRD.*

APPLICATION OF THE PRINCIPLES OF CHEMISTRY, TO EXPLAIN THE THEORY OF THE FUNCTIONS OF ANIMAL LIFE, IN HEALTH AND IN DISEASE.

1.
ature and
ife of Animals.

1. ANIMAL ſubſtances are, all,—as we have already ſeen,—compounds of the four grand chemical principles,—Hydrogen, Carbon, Oxygen, and Azote,—with an addition of Lime, phoſphor, and alkali. But, no quantity of theſe elements, brought artificially together, in whatever proportions, could afford animal ſubſtance in an organized ſtructure. There is in animal organization, a *mechaniſm*, which merely chemical agency could never produce. Yet, even the artificial imitation of this mechaniſm, added to the chemical imitation of the mixed matter of which it is compoſed, would,—were it poſſible,—never produce a living animal. A peculiar law of Nature,—that of generation,—gives the embryo form. The ſecret proceſs by which that embryo form is prepared to become the receptacle of life and ſenſibility, is carried on—only in the womb of the Female Parent, or in the extruded ovum. In what manner the ſeminal elements are primarily prepared in the bodies of both parents, is not, in all its minuteneſs, fully known.

2.
Compoſition and Structure of the Animal Body.

IVING ANIMAL, when all the parts of its body
developed, preſents itſelf to us, as a curious fabric
, Muſcles, Tendons, Ligaments, Nerves, Chyle,
Fat, Bile, Aliments paſſing by digeſtion into parts
body, excrements thrown off, Lymph, and va-
reted gaſes and juices, differing in character, ac-
as the proportions of the elementary principles are
in each. The *bones*, are the mechanical baſis,
ich all the reſt is ſupported. The *muſcles* are the
fleſhy parts which connect all the fleſh and in-
ts with the bones, and are the grand organs of
nergy. The *tendons* and *ligaments* connect the
with the bones, and with one another. The
ve their origin and principal ſeat in that which
the brain, whence they diffuſe themſelves
ut all the bones, muſcles, and other parts of the
the ſkin or *cutis vera*,—making the whole as it
ne organ of ſenſibility ;——for, the *nerves* are,
y, the ſeats and organs of ſenſation, without
has no exiſtence, which beſtow it wherever they
which,—the more frequent they are in any par-
art, render its ſenſibility the greater,—the more
y are, leave ſenſibility ſo much the more im-
Membranes wrap up the bones, muſcles, and
rts,—forming, every where, of each particular
exterior covering. Theſe different ſolid parts
buted ſo as to form venters or large cavities, in-
arteries, veins, ducts, tubes, and all the hollow
e channels through which the fluid matter of the
ody flows, the mouths by which its ſecretions are
d, the reſervoirs by which it is ſtored up. The
matter in a progreſs towards entrance into the

ſolid ſtructure of the body, they are formed from the aliment which we take in, by the action of the ſtomach and the other veſſels, the moſt immediately connected with it. They aſſume, firſt, the character of *chyle*. They are converted, in the farther progreſs of the *chyle*, into *lymph* and into *blood*. In its paſſage through the *lungs*, the blood takes in additions of air, by means of which it acquires the perfection of its character, and is prepared for thoſe ſecretions which it is to afford both while it paſſes, in the *arteries*, toward the extremities of the body, and when it returns in the *veins* to the heart. The *mucus* of the noſe, the *ſaliva* of the mouth, the *cerumen* of the ears, the *ſemen*, and ſo many other peculiar ſecretions by the *glands*, are but ſo many forms which the nutrimental matter aſſumes, while it is gradually elaborated for the increaſe and ſuſtenance of the ſolid parts. Of theſe ſecretions,—a part is conſumed, perſpired, or otherwiſe emitted from the body,—the reſt is re-abſorbed, reſtored to the lymphatic ſyſtem, and by it, conveyed to enrich the chyle, and to render the blood, the lymph, and all the other fluids more generous,—then to give new perfection to ſubſequent ſecretions, and to the ſolid matters which are formed from them. The *brain* is the grand centre of ſenſation. The *ſtomach* and *bowels* are the ſeats of digeſtion. The *liver* ſecretes the *bile* by means of which the putrefying excrement of the body, is carried off, without being ſuffered to do injury. The *kidnies* ſeparate the *urine*. The *teſticles* detach the *ſeminal fluid*. The *nerves* are probably filled with a peculiar *gazeous fluid*. And it may be, that other gazeous fluids are ſecreted and circulate in other finer veſſels,—though Anatomy have not yet been able to detect them. The *lacteals* diſtribute the *chyle* from the

ſtom.

ch into the glands by which it is elaborated into
ſhment for the ſanguiferous ſyſtem. The *lymphatics*,
ly convey nouriſhment to the grand vital ſtream,—
the ſurface of the body and from the ſurfaces of its
us exterior veſſels,—through the elaboration of the
ds A *cellular membrane* pervades and inveſts all the
us parts of the body, and is the organ of a variety of
tions. *Fat* is depoſited at various parts, to facilitate the
on of the ligaments, and to form a general ſtore of nu-
ent which may be abſorbed by the *lymphatics* for the ſup-
of the *blood*, whenever there is a lack of ſupply from the
ach, through the *Lacteals*. *Senſibility*, in a greater or
ller degree of acuteneſs, pervades every part of the ſyſ-
; maintains all the mechanical energies of its organs,
ſo contributes to all the chemical compoſitions, decom-
tions, and order of relations within it,—that, whenever
ſenſibility of any part ceaſes,—the chemical ſtate
hat part, is, at leaſt changed,—or it is perhaps wholly
mpoſed.—Such are, in general, the compoſition and
ture of the LIVING ANIMAL,—eſpecially of man.
s IMMEDIATE PRINCIPLES of the Animal Body, ſo
as theſe are as yet known to Chemiſtry,—have been
icularly enumerated in the preceding Book. Its Che-
al Elements were named in the firſt paragraph of the
ent ſection. The Animal frame is connected with an
rming, animating, ſentient principle, the laſt known
e of ſenſibility,—which, through the medium of the
ous *ſyſtem*, perceives whatever affects the exterior
ns, and which, by its power of exciting muſcular
ion, becomes the cauſe of all Animal Activity.

he ANIMAL thus framed, comes into exiſtence, in
ſequence of coition between the male and the female;

3.
Chang
Ani
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an act, in which the latter receives ſeminal impregnation from the former. In the courſe of the due period of geſtation or incubation, a new animal is organized, endowed with irritability, quickened, at length, into ſentient life, then excluded from the womb or the ſhell, and introduced into the world of animal exiſtence, as an independent, loco-motive, ſentient, intelligent being. In the womb the young animal was nouriſhed by the communication of aliment, through proper veſſels from the body of its mother. After being excluded into an independent, ſeparate ſtate, it receives nouriſhment by its mouth, through the œſophagus, into the ſtomach,—and an addition of gaſeous nouriſhment by the way of the trachea, into the blood in the lungs. While its life advances, all its organized parts are enlarged: its bones, its muſcles, its nervous organization, the capacity of its brain, ſtomach, and inteſtines, its limbs, and all the parts of the ſtructure, in due proportion. Its mind and body continually re-act on one another;—the anguiſh of the mind, impeding the ſalutary performance of the corporeal functions;—and the derangement of the ſtate of the body, diſagreeably affecting the condition of the mind. It is liable to *diſeaſe* which tends to unfit its organs for the diſcharge of their proper functions, to deſtroy the harmony of its movements, to break the connection between mind and body, and in the end, to effect an entire diſorganization and decompoſition of its ſubſtance. Its diſeaſes may begin in any of its parts,—in the fluids or in the ſolids,—in the head, the ſtomach, or the inteſtines,—in the nerves, the muſcles, the bones,—in the limbs or in the trunk of the body,—from the heart or at the ſurface of the ſkin. They begin,—either from remarkable exterior injury,—or from ſome cauſe which deranges

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es the functions, without the operation of any ex-
nechanical violence. They are, in their primary
on, local or general. Diſeaſes of the ſolids are
local, at their origin: Diſeaſes of the fluids more
extend their agency, over the whole animal
All diſeaſes are at one period or another in their
s, attended with a FEVERISH derangement of the
tion of the blood. But, thoſe which are properly
FEVERS, begin with this diſorder in the circulation,
th a correſponding diſorder in the ſtomach. Diſ-
having their commencement at a diſtance from the
al ſeats of life, ſenſation, and nutrition,—only be-
EVERS—by conſequence,—and in their ſecondary
on. Throughout life, all animals are conſtantly
o diſeaſe. But, from the period of the maturity
animal, to that at which its ſtrength and vi-
gin, in the ordinary courſe of nature, to decline,
are leſs frequent and leſs dangerous than at other
f its age. In the human ſpecies, the animal attains
maturity of growth in all its parts, between the
five and twenty and thirty years. From thirty till
n forty and fifty,—if the energies of nature be not
d by toil, exceſs, or unfortunate accidents,—the
continues in the beſt perfection,—of its health, and
all its organization. From fifty, it continues to de-
and its chance of ſurviving becomes continually leſs
, till, at laſt, between ſeventy and eighty, if it ſur-
long, the energies of life become ſo exceedingly
that the ſlighteſt hurtful accident is ſufficient to ſtop
r ever.

is the outline of the hiſtory of the health and ſick-
e growth and the decay of the Animal Economy.

3. But, the point of contact between the principle and the *material organization* of the utterly unknown. We cannot, therefore, the phœnomena of health and ſickneſs, merely conſideration of the *mechanical relations* of the frame,—and the *vital energies* by which verned. Beſides, the Animal Œconomy is thouſand influences from without, in the which, it is plain that ſomething elſe than vitality muſt be affected.

7. Chemical Re-agency in the functions of the Animal Œconomy.

In truth, we may know from the moſt certain, able evidence, that CHEMICAL CAUSES *moſt important part, in regulating the* SICKNESS *of the Animal Frame.*

Gravitation or *general Attraction* never intervention of the CHEMICAL ATTRACTION between bodies diſtant from one another, and withheld from mutual contact. It is probable analogy and appearance, though, not indeed, certain; that even the Sun, and the different ling around them, are not divided from one any wide intervals of entirely empty ſpace. But, ever matters come into mutual contact,—there CAL CHANGES are continually going on. If happen to be contiguous to one another, of parts in their preſent aggregation have no reciprocal decompoſition of theſe bodies, and tion of new compounds; continual changes enſue, till, at laſt, other affinities are co-operate, and the decompoſitions are The *atmoſphere* is undergoing inceſſant

ompoſition of its parts. In the *waters*, on the
the *earth*, above all, wherever *fire* acts the
rfully; ſuch chemical changes are inceſſantly
e. In inanimate Nature, however, the che-
ges are in truth few, if compared with thoſe
tation is continually accompliſhing. It is by
is of *vegetation*, that endleſs diverſities are pro-
he permanent combination of only three or
principles. In *Animal Life*, do we not ſee
chemical changes in the differences between
e *excrement*, the *fleſh*, the various *humours*, and
ite diverſities which theſe humours exhibit in
ickneſs? Is there a ſingle inſtance, in which
ninute parts, are effected, without the interven-
mical Agency? Is there any caſe in which the
regation is ſufficiently diminiſhed, without be-
l by chemical changes? Is it not true, that the
rful and the more conſtant the mechanical
much the more completely and actively are
l attractions brought into play?—

be denied, that the *Chemical Attractions* are
ſceptible of being combined, more intimately
s of *General Gravitation*, with the functions
Life.[*] Whenever the *Chemical Nature* of the
altered; the animal functions are more or leſs
the alteration. Every difference in the compo-
air which we breathe, of the food we eat, of the
—whatever it is—to which the excretory and
ſſels of the ſkin are expoſed, produces more
fference in the ſtate of the feelings and func-
Animal. And, *ſince*, the finer, and the more
ſtate into which matter in general is reduced,
ſo

[illegible] power. [illegible]
all the wonted laws [illegible]
ances, in this particular [illegible]
Altered configurations of the organs of fa
theſe be the ultimate changes which take
communion between mind and body? Never:
feſſed, that, with theſe, there muſt be ſo
nervous changes.—By all the laws of analog
conſider theſe nervous changes as chemical.

It is *not, then, a theory, a hypotheſis, a fa*
—but DEMONSTRATED SCIENCE,—ſcience
can poſſibly be obtained where the ma
phaſes of material exiſtence, are to be particul
—which teaches us,—that ALL THE
FACTS IN THE HISTORY OF THE ANI
NOMY,—IN HEALTH OR IN SICKNESS,—A
SARILY CHEMICAL. The chemical attracti
laſt diſtinguiſhable ties in the intercourſe be
and body. As matter muſt be in its extreme
and tenuity, where it is accommodated to re
impulſes of an informing mind; ſo chemi
muſt, in that particular condition, be the
over it, than in any other.

What, then, ſhall we ſay of thoſe drivell

ts in the phyſiology of Animal Health and Senſation,
who conſider Vitality and Mechaniſm as the ſole
uſes of every phœnomenon of the Animal Functions,
who, to lay aſleep ſcientific enquiry, to amuſe their
wn torpid minds and thoſe, of others, to delude the
orld with a vain ſemblance of knowledge in a caſe of the
oſt ſerious and awful importance, uſe metaphorical
rms in which all clearneſs of ſcientific meaning is loſt?
hat ſhall we ſay of thoſe, who, in the commencing
plication of chemiſtry to medicine, apply the newly
ſcovered chemical powers, as if they were to operate,
t naturally, but by ſome unaccountable ſpecific power,
who mingle ſomething of the language of chemical me-
cine, with the miſerable mummery of *ſpaſm* and *ſtimu-*
r, and all thoſe terms which are ſo much in every per-
n's mouth—becauſe they can be uſed without mean-
g? Indignation ſufficiently warm, contempt too arrogant,
n hardly be felt in reſpect to ſuch men. Art and
ence are, in their hands, made, alike, the bane of hu-
an life.

8. View, in detail of the chemical phænomena of health and ſickneſs.

4. Let it be granted, then;—that health and ſickneſs,
all caſes, depend principally upon the ſtate of the che-
cal relations of the parts of the Animal Œconomy;—
d that the intimate phœnomena of ſenſation depend,
ore probably upon chemical changes continually taking
ce in the Nervous Syſtem, than upon any other cauſes
hich have as yet been aſſigned:—

How do we apply theſe general truths to all the vary-
g phænomena of life and ſenſibility from the generation
the animal to its final diſſolution?

Here, we cannot attain to the ſame certainty, as in the
ion of the general truths. The field is too im-

menſe,

is, there, probably, prepared by certain cher
for its firſt organization and irritability. T
vitality, rather vegetative than animal,—
and volition of animal life, are added, as
neceſſary organization has been ſufficientl
the due relative diſtribution of the ſolids an
—the circulation and ſecretions of the fluid
For a while, the embryon or infant animal i
by matter prepared around it in the ovum,
centa,—by a communication of circulating
body of its mother. During this firſt progr
tence; the proportions of all its chemical pr
cially of its *oxygen* and caloric are augmented
cal compoſition of thoſe which have been ca
diate principles of animal bodies, commenc
it acquires that bulk and ſtrength of organiza
vivacity of life which are neceſſary to fit
exiſtence.

Excluded into a ſtate of ſeparate exiſtence, i
riſhed by milk and other ſubſtances reduce
poſſible into the ſtate of chyle, before th
veyed into the ſtomach,—by oxygen and ca
at the lungs,—by water and gazeous matter

out—lithic acid, with phoſphoric, calcareous, and alka-alts—in its *urine*,—different *excrementitious fluids*—ears, the noſe, the eyes, the mouth, and from the tory veſſels on the ſkin,—and a ſoft *ſolid excrement* the anus. The reſt of whatever nouriſhment it in, is converted into the ſolid ſubſtance of its body, long elaboration, and ſucceſſive depoſition by the fluids. whole *excrementitious matter*,—whatever its form, however it be given out,—conſiſts either of *an exceſs* *e one, or of the whole, of the neceſſary principles taken in* *riſhment*, *of matter which was requiſite to the elabora-* *f the fluids and ſolids*, but is not to be finally fixed in ubſtance of the body,—*of matter which has been fixed* in ubſtance of the body, but is, by new chemical changes, cated and evolved,—or of *new compounds* formed in the body, *in conſequence of diſeaſe*. The matter is fixed within the body, or retained in a fluid form, s into the blood, the fat, the bones, the bile, the h, &c. But, *nothing can be more probable than that a* *f it, takes an* ELASTIC-FLUID *form, fills the finer* , *but eludes the diſcovery of the anatomiſt, becauſe it* *t ſubſiſt in its elaſtic-fluid form in the temperature of* r. All the analogies of Nature and human life, fa- this opinion. There can be nothing more probable, hat there does, indeed, exiſt a *nervous fluid* of extra- ry elaſticity,—in the changes of which is the laſt uſe between the material and ſpiritual parts of nimal,—and which is death, in driven off or reduced ty.

e growth of the infant ſeems to be in a great mea- he reſult of *ſenſation* and *volition*, acting through

chemical

chemical media. Every hour of the young anim
ence preſents new objects to his ſenſes, pours ne
ledge into his mind, excites him to new and reſtl
vity. Theſe multiplied ſenſations, this increaſing
ledge, ſuch impatient activity, promote all the me
movements of all the parts of his frame. The me
movements ſerve to [illegible]ve the changes of poſition,
ture, &c. which are neceſſary to quicken and aug
chemical agencies. The quickened and augmen
mical agencies,—increaſe all the *abſorptions* and
—increaſe the depoſition of matter to enlarge
parts,—increaſe, alſo, the formation of thoſ
fluids which are the laſt reſults of animalization
grows the frame,—till activity becomes, at len
briſk and reſtleſs,—till the muſcle and the nerve
quired a rigidity of texture in which they are leſs
to the power of ſenſation and volition,—till new
and excretions take place by which all that
carried off, which might have been, otherwiſe,
to augment the general bulk of the Animal Org

All the *diſeaſes of infancy* are plainly to be r
the pre-eminent influence of *chemical agency.*
them ariſe from indigeſtion in which the *ſtomac*
peculiar juice ſecreted into it, being render
to produce the requiſite changes of chemical co
upon the ſubſtances conveyed into it, gives riſe
ſequent diſorder in all the ſecretory and circul
tem. *Others* enſue from diſorders in the *Lympha*
and the abſorbents, of which in their firſt feeb
irritability, the chemical energies are eaſily in
the abſorptions and ſecretions altered, by the
digeſtion of the ſtomach, or by the

9. Teething.

y act upon them at the ſkin. One of the firſt e events which takes place in the progreſs of the ɪwth, is *the production of its* TEETH. This is *a chemical ſecretion.* An extraordinary quan- *ſphate of lime* has been for ſome time forming ɔd and other fluids. It is more than is requiſite ɪe growth of the former bones. It is depoſited gans in a ſituation to which it is naturally drawn ɪnſation and volition. Its ſecretion and depoſi- ɪrfully affect the whole circulating and ſenſitive d call into exercife, the whole chemical energies dy. It therefore excites fever, and endangers . The chemical proportions of the different ɪe body, are more or leſs altered from their pro- y ſtate, by this great chemical change: And, it ome time after the ſevereſt throes of *teething* ɪild recovers its full vigour.

10. [illegible]tion [illegible]al Fu[illegible]ns in the Animal Body.

hat is the ordinary ſucceſſion of the che[illegible] in the Animal Functions of the Body in [illegible] *omach* poſſeſſes a muſcular energy to aſſiſt in comminution of the food may be requiſite, after ɪ has been effected in the mouth. Solids paſs omach, intermingled with the *ſaliva* from the ands of the mouth. In the ſtomach, they are ngled with the *gaſtric juice,* in a certain warm re. *Animal* ſubſtances pretty generally,—*vege*- ances, for the greater part,—are here, in conſe- comminution in the mouth, mixture with the ſequent mixture with the gaſtric juice, expo- muſcular action of the ſtomach,—brought as a ſtate of putrefactive fermentation, as is poſ- bout that fermentation actually taking place.

They

They are now transferred into the *lacteals* into ſom
ference of temperature, a difference of conſiſtency,
ference of ſituation with reſpect to the veſſels prepa
receive them. As they paſs at every different cha
veſſel, at every different gland, peculiarities of te
ture, of comminution, of matter prepared to attract
from the ſtream into union with itſelf, occaſion ne
mical Combinations,—the various fluids, ſolids, and
which are neceſſary to the Animal's health. In the
greſs, the *blood* and the *lymph* are undergoing co
changes. As the blood is altered by the depoſition
part, or by one ſecretion, it is renovated by new
poured into it from the abſorbents. Theſe matters
ceſſary to the new attenuations, combinations, depo
ſecretions which are to take place in its farther p
Thus is the generous ſtream ſtill kept up, and re
&c. *to afford* all the peculiar fluids, all the gaſes,
the *different* ſolids which are to be formed from it
ſmalleſt alteration in the abſorptions and ſecretion
the character of the blood. When the period for
cretion of the *ſeminal fluid* arrives, another great
takes place in the Conſtitution of the Animal. Th
ſort of convulſion of Nature when this new f
comes to be ſeparated from the blood. If it be ſ
in too great quantity, and ejected from the bod
to leave no re-abſorption; the frame is weaken
the ruin of the health endangered. Its regular ſ
and re-abſorption in a proper quantity enrich the
more than any thing elſe, and contribute in the r
markable manner, to the perfection of all the fine
The formation of this fluid is evidently ſubject to c
laws. The relations of mechaniſm and the powe

are more imperfect in their influence upon it. Che-
changes are gradually induced upon the ſolids, and
all the veſſels which theſe compoſe, till the ſecretions
the finer fluids are altered, and the blood by conſe-
e loſes its former chemical character. Irregular and un-
y ſecretions enſue. Theſe continually alter the blood,
e alteration of the blood, alters the ſolids; till *ſan-*
tion, circulation, ſecretion, *ſolidification*, are ſtopped
er. It rarely happens that life is thus gradually deſ-
d. In its ordinary courſe, while the chemical
es become continually more and more inconſiſtent
a ſtate of health; the mechaniſm is alſo weakened
eranged: and all the corporeal parts become leſs and
bedient to the influence of underſtanding and volition.
ſtate of things, the ſlighteſt *mechanical* convulſion,
malleſt *chemical* diſorder, even a moderate burſt of
n affecting the feelings of the mind, will be ſuffi-
to interrupt for ever the vital functions. It is ſeldom
itality is ſuffered quietly and inſenſibly, to periſh,
ut being deſtroyed by ſome ſort of irregular force.

II. Of Stimulus.

enter, yet more particularly, in one or two caſes,
his inveſtigation;—what is it that medical Theoriſts
called STIMULUS? *Something that excites all the func-*
f Vitality into briſker and more energetic activity.
things which accompliſh this, are almoſt all the ap-
s, paſſions, and affections of the mind, but fear or
w,—almoſt all lively motions of the body,—either
en, azote, hydrogen, or carbon, or any very
e ſubſtances preſented to the ſtomach or the ab-
ts, in a ſtate in which they can paſs without any
of internal chemical decompoſition, to the immediate
s of life. Alcohol, æther, opium, aromatics, gaſ-

ammoniac,

ammoniac, gas-oxygen, water and beer impregnat carbonic acid, all *ſtimulate for* no other reaſon but all theſe matters preſent the firſt elements in the c compoſition of animal ſubſtance, in a ſtate in whi enter with the rapidity of lightning into the com of the moſt exquiſitely fine parts of the animal fram its ordinary che [illegible] mpoſition, the Animal Sy always ſuſceptible [illegible] eiving with advantage an e dinary addition of any one of its four elementary Hydrogen, Carbon, Oxygen, or Azote. To a degree, this addition will only ſerve to enliven the

12. Theory of Drunkenneſs.

ſary ſucceſſion of the chemical proceſſes,—juſt as a mical compound is formed in the laboratory—o much the more readily on account of the preſence of its ingredients, ſomewhat in exceſs,—or, juſt functions of vegetation, are, *for* a time enliven exceſs of dung, water, lime, heat, light, &c. B exceſs, augmented, will have a neceſſary tendency range the whole order of chemical proceſſes in th mal Syſtem ; preventing what *ſhould* take place *ſubſ* in one ſeries of veſſels, by means of that which *do* place, *previouſly*, in a *different* ſyſtem of veſſels. any one of the four elements of animal ſubſtance,— when firſt preſented in exceſs, it quickens and enliv whole functions,—yet, if continued to be preſented ſame exceſs, deranges thoſe functions, inverts them, them languid. The feelings of the vital principle, an of diſorder in the mechaniſm and hydraulics of the fra company all this. But, it is, nevertheleſs, chemic *fluence* that has the moſt important action through whole. The Animal functions are what they ca *mulated*, when an addition of an ele

into the fineſt ſubſtance of the body enlivens all the
of internal chemical proceſſes. They are *relaxed* by
ume element, when it continues to be added in ſuch a
exceſs, as to produce in the whole digeſting circulat-
and ſecreting Syſtems, new chemical combinations
hich the animalization of the matter taken in for the
ort of the body, is vitiated or utterly deſtroyed. A
in quantity of alcohol, of æther, of gas oxygen, &c.
ens and invigorates Addition of any of theſe mat-
to a great exceſs, produces oppoſite *effects*. That
ULUS ſo called which is received from quickened
y *motion*, is ſimilar in its operation. Applied to a
in degree, this *increaſed motion*, only makes all the
nal chemical proceſſes to proceed with a ſalutary in-
e of activity. Continued beyond a certain period, it
s the order of the chemical compoſitions, produces
pounds unfit to enter into the ſubſtance of the Animal
r in health, and thus relaxes and enfeebles the whole
e. As to that *excitement* or STIMULUS—*to uſe the
language of a fooliſh theory*—which originates in the
ations and emotions of the mind;—its action is not
diſſimilar to that of bodily motion. It firſt quickens
thus improves the whole ſeries of chemical proceſſes
nging to the *Vital Functions*. But, any one high
ion of the mind, if long ſuſtained deranges the vital
tion and relaxes the vital energy, by deranging the
ior chemical proceſſes, and occaſioning a production
mpounds ſuch as cannot advantageouſly enter into
compoſition of the human body in health. In all
changes,—both thoſe which are ſalutary, and thoſe
ch are otherwiſe,—it is ſtill CHEMICAL AGENCY
ch operates with predominant *influence* and activity.

Book. IX. Sect. III.

MECHANICAL AGENCY acts more remotely, an
able to reach to the minute diviſions and combina
matter. MIND is not predominant over that m
which it is embodied—to ſuch a degree, as to ſw
ordinary laws of matter to its will. It is, therefo
Chemical Ag lominates—though not wi
due conjunction two other influences.

13. Animal Heat.

Animal Heat f is o conſiſt in the quantity of
conſtantly preſer w hin the human body. T
loric exiſts there, either in combination with the
the liquids, and the ga es of the body, or in the
tranſition, out of one combination into another.
Caloric which exiſts in actual combinations, cann
itſelf ſenſible otherwiſe than by the rarefaction
attractions of thoſe combinations. *That* alone is
heat which is in the act of tranſition—out of one
nation into another. Heat and cold become diſcer
our ſenſes, whenever ſuch tranſitions take place.
the tranſition is from a *ſolid* to a *liquid* combinatio
liquid combination to elaſtic fluidity,—there is a
diminution of *heat*. If, on the other hand, the *tr*
be from a rarer to a denſer ſtate of combinatio
heat is, then, ſenſibly increaſed by it. All diſenga
of liquid or gazeous matters from the human body
to diminiſh the quantity of its *caloric* or *ſenſible*
All fixation of matter from a *fluid* or *gazeous* into
ſtate, increaſes that *ſenſible heat*. As moſt of the
ſtances which we take, as food, into the ſtomach,
paſs, in digeſtion, from a denſer to a rarer ſtate,—t
not, generally, augment the *ſenſible heat* of the
body. On the other hand, the gas
or imbibed over the ſurface of the

paſſes, in nouriſhing the human body, from a rarer a denſer ſtate, and, therefore, giving out *Caloric* in the ſition,—neceſſarily contributes, in the moſt eſſential nner, to maintain the animal body at its due warmth temperature. The natural functions of the Animal Economy tend continually, though not at all irreſiſtibly, o maintain the Animal Body in its ordinary temperature. hen the tranſitions of the *Caloric* are greatly multi- ied, then theſe neceſſarily produce new combinations, id or gazeous; which, paſſing off in ſweat, tend to unteract that too rapid fixation of matter in the body, which the increaſe of its heat had been occaſioned — hen, on the contarary, the tranſitions of *Caloric* within body are diminiſhed, there is, in many circumſtances, atural tendency in the frame to imbibe a greater pro- tion of *Caloric* from without, by depoſitions on the gs, and by abſorptions at the ſurface of the ſkin. The *untary energies of vitality* tend to increaſe the quantity heat in the ſenſible tranſition through the body, by ickening all thoſe movements, by means of which the ation of matter within it, is promoted. *Bodily Motion* es the ſame thing,—quickens, mechanically, all the in- rior movements, ſo as to promote, for a time, all thoſe emical changes and ſecretions which belong to the animal functions.

14. All diſeaſes are principally chemical.

After all this, ſhall we heſitate to refer almoſt all diſ- s to a chemical origin? In what diſeaſe is there not alteration of the digeſtion in the ſtomach, of the ſecre- in the bowels, of the circulating fluids, in whole or part, of the ſecretions and abſorptions at the ſkin, or throughout the whole lymphatic ſyſtem?—FEVERS all ſorts, in which fever is the primary and principal

ſlow de-oxygenation, produced either by the
the *evolution* of oxygen in a proportion
in which it is taken into the animal or veg
15. Fever. *Fevers* vary in their character, according as
hydrogen, oxygen, or azote, which is, in thi
of them, preſent in exceſs, or defective. Th
be taken in, either at the ſtomach, by the l
the abſorbents of the ſkin. It is moſt frequ
abſorbents that the *contagion* of fever is rec
account for *contagion*, otherwiſe than by the
of its being diffuſed in gaſes? How accou
perſion of *contagious effluvia* through the ai
analyſis of that air affords only gas-hydrogen,
carbonic-acid-gas, or gas-azote;—unleſs we
the infection muſt, for the greater part, conſi
tered proportions of theſe four gaſes? Does
infection in its commencement act ſomewhat
cation of *yeaſt*, to bring on the vinous fermen
decoction of malt—or that of a *red heat* to
commencement of *burning* in our *ordinary fir*
mencement of the chemical changes in fever,

compoſitions have once commenced, that matter
as once changed continues to furniſh the affinities
to produce the ſame change on the ſound matter
ous to it. Thus is feveriſh infection diffuſed
the whole human frame, till it is ſtopped by ſome
ting from within, or from without—or terminates
nal derangement of all the changes of the organic
is, and in the conſequent diſſolution of life.—Epi-
al feveriſh diſtempers, in various inſtances, as of
ſles; the *ſmall-pox*, &c. can take place only once
ourſe of life, in the ſame animal. To what ſhall 16. Small-pox.
bute this? It is, no doubt, produced by a *peculiar*
which, for the firſt time, induces a change upon
on of the abſorbents at the ſkin,—a change by
he whole chemical changes in the body are materi-
ienced, but which alters the energies, the ordinary
and even the ſtructures of the abſorbents at the
n alteration that renders future infection, and conſe-
ver, for ever impoſſible. As the infection of the
x is owing to a peculiar animal ſecretion,—not to
ariation in the proportions of the gaſes in the at-
e,—it may, perhaps, by extraordinary preventive
at length entirely extirpated from among man-
But ſuch an event is ſcarcely to be expected, if we
what complex, widely-extended and long-conti-
es it would require. What has been ſaid of late
ng the poſſibility of effectually anticipating the
e in the human body, by inoculation with the
—a ſimilar, but much leſs feveriſh diſeaſe,—is but,
tolerably juſt, and is to be explained, where it is 17. Cow-pox.
on chemical principles. The *inoculation* of the
induces a change upon the chemical action and
relations

relations of the abſorbents,—which, *in ſome caſes,* produce that permanent alteration, of which the new nities may, for ever, prevent the infection of the ſ pox,—*in other caſes,* may fail to accompliſh this com alteration, even though it come very near to it. Th ficacy of the *cow-pox* as a preventive of the *ſmal* muſt, therefore, eedingly, with every variati circumſtances. ence in the malignity of the ter, in the health, th x, the age, of the perſon i lated, in the circu nces of air, &c. in which the from inoculation was i duced, in a thouſand other dents of the diſeaſe, will produce correſponding diffe in the power of the *cow-pox*, as a preventive. But, ſ it is not prudent, without the hope of advantages mo ciſive and more important, than this project promiſ introduce a new poiſon into the number of thoſe infe by which the health of man is already ſubject to be deſtr *Gout*—has it not its origin in a derangement of thoſe mical actions by means of which the matter of the l is ſecreted?—*Rheumatiſm.*—what is *it* but an alterati the *electrical capacities* of thoſe parts of the body in w it is felt. Even *palſy*, and all that train of diſeaſes w ſeems to leſs accurate obſervation, to depend chiefly a deficiency in the ſpiritual energies of the frame,— be to have, for the principal part of them, an alter in the chemical parts of thoſe finer animal functions w they deſtroy?—*Scurvy* evidently depends upon a defic of the proper quantity of *carbon* in the ſyſtem, and the paſſage of crude, undecompoſed neutral ſalts int blood. The *Stone in the Bladder*—Does not it origin the formation and detention of an exceſſive quanti lithic acid within the body?—*Few* xceſſive *ſenſible heat* in the body. Exceſſive diminu-n of the ordinary heat of the human body, or addi-s to it, are apt to induce *fever*. The exceſſive heat ich follows upon *fever*, is, no doubt, occaſioned by *rapid fixation of the fluids* ; Exceſſive additions of t occaſion fever—by producing this too rapid fixa-n; *Exceſſive cold* acts by altering the order of the che-l affinities which act in the vital functions in ordinary th. In the caſe of *inſanity*, and other diſorders which n to depend much more on the ſtate of the mind, than hat of the body, it will be found, that *the grand phæ-na of the diſtemper conſiſt in a diſordered chemical for-n of thoſe exquiſitely fine gaſes which move in the veſ-of the nervous ſyſtem.*

18. Medicinal uſe of the Gaſes.

k we, what advantages are to be expected from the icinal uſe of the gaſes? It muſt be owned, that, as gaſes have been, hitherto applyed in medicine; they ſerved for little elſe, than to evince the *deluſions of en-ſm*, or the *impoſture of quackery*. It is only the tran-occaſional application of this or that gas, through ngs or the abſorbent ſyſtem, which has been, as yet ed. It is not impoſſible, that a criſis of this or that iſh diſtemper, or ſome briſk action upon the nervous of the frame, might thus be produced. But, to ren-ch a criſis truly ſalutary, the concurrence of a mul-of other cauſes, would, moſt probably, be requi-And any tranſient and exceſſive excitement of the ſyſtem by the agency of exterior cauſes, however few moments, beneficial, will uſually prove to be end, in the higheſt degree pernicious. We have ained, in the medicinal uſe of the gaſes, to the of changing our *reſpirable*, and *abſorbible* atmoſ-

phere

taken into the ſtomach. Above all, we h
able to do any thing in the medicinal applic
from which might be expected that complet
the fluids and ſolids, and of the habitual fun
malization, from which alone can the cure c
are called chronic diſtempers, be obtaine
trials with factitious airs have made empiricall
dom, not upon any ſound ratio of proceſs. Th
made by men who joined not to ardour and
due ſcientific coolneſs of mind. They have be
uſed as tricks of quackery, the expedients o
ing phyſicians to procure for themſelves, a
tinction. Very recently, Dr. Beddoes,—a
19. Inhaling of Nitrous Gas. enthuſiaſm, perſeverance, and philanthropic
not undeſerving of praiſe,—has, with the aſ
Mr. Davy, diſcovered, that *nitrous gas*, the
of azote with oxygen, when inhaled by the
duces effects highly animating and exquiſite
upon the whole nervous ſyſtem. So much
to be expected : for nitrous gas is a combina
and *oxygen*, two of the primary elements of a

arts of its fineſt ſubſtance, as quickly and directly as
oſſible ; No very complex combinations and decompo-
ſitions are to be *effected, before* the matters thus intro-
uced, can be converted into animal ſubſtance. And,
we have already ſeen ; *that, the ſimple elements of animal*
ubſtance, preſented—either ſingly, in binary, in ternary, or
n other eaſily decompoſable combinations, are the only things
which produce what is called nervous excitement ; and that
hey do produce this excitement ſolely by the rapidity with
which they are completely introduced into the compoſition of
he animalized ſubſtance. It is highly probable that *any*
ESPIRABLE *combination of oxygen and caloric with any*
ne of the other elements of animal ſubſtance, would if
haled by the lungs, occaſion an excitement more or leſs ſi-
ilar to that which is attributed to nitrous gas. Beſides,
otwithſtanding the number of caſes and experiments
ated by Dr. Beddoes,—the report of all the perſons who
ave ſubmitted to the trial of nitrous-gas, is not uni-
rmly in favour of its agreeable exciting powers. Nor is
ny thing more uncertain or fallacious than animal ſen-
tions. What accurate knowledge had we of heat be-
re the invention of the thermometer ?

III. What uſeful inſtructions does all this afford, to 20. Proper ſtudy of Medicine.
rect us in the ſtudy and practice of medicine ?

It firſt evinces, that, except in the application of Ana-
my to Surgery, there is no ſuch thing as genuine ſci-
ce in the preſent practice of the Medical Art. The
hole practice conſiſts ;—either in the adminiſtration of
medies, empirically, and at random ; or elſe in admi-
ſtering them according to ſome *fancied relations and ener-*
s of vitality,—which are not at all aſcertained,—and
which

hich are, yet, ſuppoſed to act and re-act with the me- anical powers and agencies of the animal frame,—with- ut any *intermediation* of chemical relations and powers. But, however we may have erred in the explication of the articular agencies which operate in this or that caſe of ealth or ſickneſs; we certainly have not failed *to demon-ſtrate with irrefragable force of evidence; that, there is, in ruth, a certain chemical agency, intermediate, in all the animal functions, between the mechanical movements and the* vital energies. This being ſo; the medical theories of Cullen, of Brown, of Darwin, however modified by their diſciples, muſt neceſſarily fall to the ground. No man who does not deſire to draw upon himſelf the guilt of murder, will preſume to act upon them. It muſt, henceforth, be the grand object of medical inveſtigation, to aſcertain what are the true chemical relations and agencies of the animal organs and functions in every poſ-ſible caſe of health or diſeaſe. The proper ſtudies of the young phyſician ought to be, 1. ANATOMY, in the ut-moſt accuracy and minuteneſs of examination; 2. The NATURAL HISTORY or PHYSIOLOGY *of animal health and ſickneſs*, preciſely aſcertaining all the obſervable ap-pearances in every varied ſtate of the Animal functions 3. The NATURAL CHEMISTRY of health and ſickneſs or all thoſe chemical changes which are the ultimate dis-cernible phœnomena of matter, in the re-actions of body and mind. Upon theſe ultimate phœnomena of matter in the re-actions between body and mind, the cauſes of health and ſickneſs *muſt* chiefly depend. And when the ſhall be fully known, Medicine will, at leaſt be exalte to the genuine dignity of truth and ſcience.

2.

little that an attention to that which is the
he functions of animalization, can contribute to
diate improvement of medical practice. It, how-
ches cautious moderation in the uſe of all thoſe
e called *ſtimuli*,—many of them, it will even
to baniſh entirely. It encourages us to ſeek
of peſtilential fever by *cold* and by the preſence
l-ventilated atmoſphere, containing a duly pro-
mixture of the ſalutary airs, &c. It accounts
ubtility and the—as it were—ſeeming caprice—
on. It directs us—never to uſe, too conſtantly,
ercise or reſt, or any one ſpecies of food, or
ſort of drink, or any one ſort of abſorbible or
air. It explains why heat and cold, may
now relax the animal frame. It ſhews elec-
us, as uſeful in its influence on the animal
y ſerving as a ſtore in which caloric may be re-
as not to do injury while it is not wanted, but
be perhaps inſenſibly convertible into vital heat,
r it is wanted in the body for that uſe. It ac-
r the growth of infancy, for its diſeaſes, for the
conſtitution which take place at different periods
of the animal, for the maturation and the de-
he animal conſtitution. In all this, it preſents a
of the moſt important leſſons to the individual
reſervation and improvement of his own health,
as to phyſicians in reſpect to their advices and
ons. It explains the reaſon, why, in a ſalutary
he fluids and ſolids, no emotion of the mind, no
cal influence from without, can induce diſeaſe.
ing the probability of a conſtant circulation of
fluids within the human body, it accounts for
all

21.
Chemical directions for the preſervation of health.

SECTION FOURTH.

VIEW OF THE PRINCIPAL CHEMICAL ARTS.

I.

Working of Mines of all ſorts, and the refining of Metals.

HESE are, no doubt, the firſt Arts in which Che- ſtry is employed, in preparing foſſils for the accomo- tion of human life. In theſe, Natural Hiſtory, Hy- licks, and Mechanics, are aſſociated with Che- ſtry. 1. Science of the Working of Mines

Natural Hiſtory examines and indicates the mountains, ſtrata, the particular gangues, in which minerals are be found. The ſcience of *Mechanics* directs the miner, opening up his metallic veins, in driving his ſhafts, in ſerving the requiſite communication between the mine the atmoſphere above, in hewing out the metallic ners for the ſake of which he has pierced the boſom the Earth. The laws of *Hydroſtatics* and *Hydraulics*, operate with thoſe of Mechanics, in enabling him to away the water which threatens to overflow his nd to raiſe to the ſurface, the maſſes which he 2. Natural Hiſtory, &c. of it.

has cut out beneath. In ſalt-mines, coal-mines, tin-mines, copper-mines, ſilver-mines, wherever, in ſhort, the matter is to be procured from a hidden depth in the bowels of the Earth, the management is ſtill the ſame. The intervention of Chemiſtry does not commence, till after the foſſil matters have been procured.

3. Chemiſtry; of it.

Then, indeed, it does commence. The operations of *waſhing*, *pounding*, *roaſting*, *fuſing with fluxes*, *cupelling*, *parting*, at laſt, give the metal in its requiſite purity. Or, if the *Humid Way* of purification be, in any inſtance, preferable; it commences after the pounding of the ore; and proceeds by employing Acids, &c. according to the laws of their affinities, till the pure metal is, at length, precipitated. Or, the *Humid* and the *Dry Ways* may be combined. Theſe are, in brief, the chemical operations requiſite in the *refining* of metals. But, theſe have, already, been, unavoidably, explained as much in detail, as it is poſſible to explain them within the limits of the preſent work. The *mixing of metals*, which gives our braſs, pinchbeck, prince's-metal, &c. by the amalgamation of baſer metals with others which are ſomewhat more precious, or even with one another,—is, alſo, chemical: But, the rules by which it is to be conducted, have, been, already explained in our chemical hiſtory of the different metals.

II.

uions of certain ſaline Subſtances for the uſes of the Arts.

MISTRY is eminently *beneficial* to human life, in g a multitude of mineral ſalts for its uſe. The l preparation of a few of theſe, ſhall be, here, rticularly explained.

1. Kitchen Salt.

mmon Kitchen-Salt or *muriate of ſoda*, is one of the eful of all the ſaline preparations known to Che- Where this ſubſtance is found naturally pure d in mines,—as in thoſe of Poland, Hungary, &c. aration is, for the greater part, mechanical.

2. Prepared by ſpontaneous evaporation.

otherwiſe, to be chemically prepared from the f ſalt ſprings, or of the ſea. From either, it may ared by ſpontaneous evaporation under the heat of ,—or by evaporation in cauldrons by the heat of .

3. Prepared and purified by artificial evaporation.

n it is to be prepared by ſpontaneous evaporation, ea water may be conducted into trenches formed ve it on the ſhore. Theſe trenches may be, rather han deep. They are to be divided into com- nts. Their interior ſides ſhould be covered with They have ſluice-gates open to admit the tide,— t to retain the water in them, when it retires. atum of water is then evaporated by the heat of . The ſalt is condenſed, upon it in ſucceſſive pel- till all that it can afford, is obtained in a concrete This muriate of ſoda, contaminated with a variety r ſalts, is to be purified from theſe, by a lengthened which takes away ſulphuric, magneſian, and calcareous ſalts, yet does not, in the end, afford the muriate of ſoda in a ſtate of conſiderable purity or fineneſs.

4. Prepared and purified by artificial evaporation.

As *Sea-water* is eaſily diſtillable; evaporation by fire, where fuel is ſufficiently cheap and plentiful, is preferable to the more tedious proceſs of ſpontaneous evaporation. A ſuitable artificial heat evaporates the water, leaving the ſalt dry. The cauldrons ſhould be broad and ſhallow. As the evaporation takes place, the *ſulphate of ſoda* or *Glauber's ſalt*, and the *calcareous ſulphate*, being leſs ſoluble in water than the *muriate of ſoda*, will be cryſtallized before it: And theſe, therefore, may be eaſily ſeparated by drawing off the ſolution into other cauldrons, when the former ſalts appear in a ſolid ſtate. The *magneſian ſulphate*, which alſo exiſts in the ſea-water, is much more ſoluble than *muriate of ſoda*, in hot water: And therefore, this *magneſian ſulphate* will remain fluid after the cryſtallization of the *muriate of ſoda*; and may be drawn or poured off, ſo as to leave the *muriate of ſoda*, pure and dry. Both *muriate of lime* and *muriate of magneſia* are more ſoluble than *muriate of ſoda*: And thoſe ſalts will, therefore, go off in the ſolution with the *ſulphate of magneſia*. This is an extremely ſimple proceſs; and will afford beautiful ſalt, in a ſtate of the higheſt purity.

5. Hiſtory of this Manufacture.

Salt is made near Liverpool, from the water of ſalt-ſprings impregnated with rock-ſalt. The art of manufacturing it, was originally introduced from Italy, Spain, and France, to thoſe which were called the Low Countries of Germany. From theſe, it was brought into Scotland in the beginning of the ſixteenth century, at a great expence, and not without the granting of extraordinary advantages to thoſe foreigners who introduced it. It was already practiſed in England; but,

not,

ot, as it ſhould ſeem, with happy ſkill. The Engliſh
ere willing to import ſalt of the new manufacture, from
cotland: And the Scottiſh Government, with the jea-
uſy of foes and rivals, forbade the exportation of their
lt to England. To the Northern Countries on the Con-
inent of Europe,—Denmark and Norway,—they found
eligible to permit the exportation of the beſt Scottiſh
lt, on account of the advantages which were to be ob-
ined, in return. Ever ſince that period, ſalt has con-
ued to be largely manufactured in Britain. The ne-
ſſities of the fiſheries of herrings, ſalmon, and white-
ſh, have long given the higheſt encouragement to the
anufacture. All the countries on the Baltic, are, at
eſent, ſupplied with their beſt ſalt from England,—eſ-
cially from the ports of Liverpool and Hull.

6. Preparation of Soda.

2. *The Preparation of Soda* is to be alſo numbered
ong the common chemical arts. This ſubſtance is to
obtained, in theſe countries, only in the two ways of
e *incineration of marine plants*,—and the *decompoſition*
muriate of ſoda or *common ſalt.*

7. Soda from Barilla.

The *Kali*, *Barilla*, and a diverſity of plants growing
the Scottiſh coaſts—of which the aſhes have been diſ-
nguiſhed by the name of *Kelp*,—are the plants from the
cineration of which we obtain our ſoda. Such is the
ſparity in value between the aſhes of *Barilla* and thoſe
Kelp; that, when the former are ſold at the price of
45. Sterling in the London-markets,—the *latter* can be
ld for no more than £10.—a ton.—All the plants which
ord ſoda, appear to derive it from the ſea-water with
hich they are nouriſhed, in their growth. Probably,
e ſoda—if not rather the muriatic acid of ſea-water or
oxygen—enters into the plants, in a ſtate of extreme at-

tenuation,

tenuation, and, after being elaborated by their organic functions, is, at laſt, fixed in them, as ſoda. The ſimple incineration of the *Barilla*, affords a large proportion of tolerably pure ſoda, in its aſhes.

8. Soda from Kelp.

Kelp has been prepared, for a long period, on the coaſts of England and Ireland, by the incineration of four well-known marine plants,—the *Fucus Nodoſus*,—the *Fucus veſiculoſus*,—the *Fucus ſerratus*,—and the *Fucus digitatus*. All plants capable of growing under the afflux of ſea-water, are, no doubt, capable of yielding it in a ſmaller or a greater proportion. Since the year 1723, it has been prepared, from the ſea-weeds on the South-Eaſt coaſts of Scotland, and in the Orkney Iſles. The glaſs and ſoap works of Newcaſtle, firſt, preſented a market which engaged the Scots to attempt this manufacture. About the year 1746, the manufacture was, for the firſt time, tried, on the weſtern coaſts of Scotland. Its produce was then deſtined for the uſe chiefly of the Iriſh bleachers. Since that time, the burning of the above-mentioned ſea-plants, for *Kelp*, has become a very general object of attention around all the Scottiſh ſhores. It yields, at preſent, hardly leſs than £50,000 Sterling a year to the people of the northern coaſts of Scotland, and its adjacent iſles.

9. Preparation of Kelp.

Its preſent manufacture in thoſe parts, is eaſy and ſimple, but careleſs and imperfect. The plants are, in Spring and Summer, to be cut with a ſickle, or rather a pair of ſtrong hedge-ſciſſars. They are left to dry on the ſhore. An oblong area is then ſurrounded with a wall of looſe ſtones, to the height of 2 or 3 feet. Fewel, ſuch as heath or peats, is put in, to fill the incloſed ſpace. Over the fewel, are heaped the ſea-weeds The whole is kindled. It is incinerated by continued fire, which is not ſuffered to blaze

out

t into a flame. The red heat is maintained till the ſoda ume the form of a melted maſs in congelation. The la thus obtained, is exceedingly impure; being conta- nated with earth, potaſh, magneſian alſo and calca- ıus ſalts, with a mixture of carbon, and of carbonic d. It is, beſides, but carbonate of ſoda, not the cauſ- alkali.

10. Improvement propoſed, in the making of Kelp.

The inferiority of *Kelp* to the *barilla* of Spain and ily, is owing much more to the imperfection and care- neſs of the Scottiſh mode of preparing it, than to any erence of quality in the plants from which it is made. improve it,—the plants ſhould be freed from every extra- us mixture by waſhing in the ſea-water;— they ſhould ried without any new contamination in the drying, and ed without any ſolicitude to make them exceedingly . They ſhould be burnt in a furnace, preſerving the el ſeparate from the ſea-plants, and ſo conſtructed, : the ſoda might flow into a proper receptacle as it e into fuſion. This altered proceſs requires only the nation of buildings for the burning and ſubſequent pre- ation of the *Kelp*. For theſe, the increaſed value of manufacture, would afford ample compenſation. ce it is of ſo much value; and ſince the ſea-weeds on ſhores, are annually renewed; it is, ſurely, not too ch to expect, that the improvement here hinted at, y, within due time be generally adopted.

11. Teſt of the purity of Kelp.

It is known, in what proportions ſoda, water, and this that acid, exiſt together reſpectively in the different ral ſalts, into which this alkali enters. We may, refore, aſcertain the proportion of ſoda in an ounce, a ind, or any other quantity of *Kelp*, by immerſing it in wder into a given quantity of any acid of which the exact ſtrength is known; and then, eſtimating, accurately, the quantity of the cryſtalline neutral ſalt which we obtain.—Our bleachfields, ſoap-works, and glaſs-works, are ſuch as to leave us no reaſon to dread diſcouragement to our Northern manufactures of *Kelp*.)

It is becauſe *Soda* is uſually conſidered rather as a mineral ſubſtance, that we ſpeak of its manufacture, rather here; than in a ſubſequent Section.

3. Of the manufacture of *Pot-aſh*, ſomething may be alſo ſaid here, though it be obtained from vegetables only,—ſince it is ſo nearly related in its qualities to mineral ſubſtances. Much, however, we ſhall not need to add to what was ſaid of it, in the former part of this work.

12. Manufacture of Pot-aſh.

The *Pot-aſh* in the Engliſh market, is imported from Ruſſia, Poland, and North America. It has, alſo, been uſual to prepare *pot-aſh* by the incineration of ferns and various other plants otherwiſe uſeleſs, in Scotland, and other parts of theſe Iſles. In the countries from which we import it, *Pot-aſh* is prepared—chiefly by burning green timber. The timber is burnt in a ſmouldering fire. The aſhes from this fire are lixiviated in boiling water. By the lixiviation the pot-aſh is diſſolved; while the contaminating matters, either ſwimming on the ſurface, or ſubſiding to the bottom, are thus ſeparated from it. The lixivium, ſkimmed and poured off, is, again, expoſed in cauldrons, to an evaporating heat. Evaporated to dryneſs, in the open air, it affords the deſired ſalt in chryſtals of *carbonate of pot-aſh*. It is, in this ſtate, that pot-aſh is produced in the market.——It is, generally, very impure. It is employed by the bleachers, the ſoap-makers, and even the glaſs-makers, &c.

13. Preparation of Nitre.

4. Of all our chemical manufactures, that of *Nitre* or *Petre*, is one of the moſt important. *Nitre* or *Salt-re* has been made in England from a very remote period time. But, even ſo late as in the beginning of the gn of Charles the Firſt, it appears, that, not above a rd part of that required for ordinary conſumption, was de within the realm. The urine of cattle and of fami-s, the floors of dove-houſes and of ſtables, were appro-ated, at that time, to the Crown, as materials for the nufacture of Salt-petre. In other countries, and at r periods, the rubbiſh of old houſes, and the mellow th of ſtables, cellars, &c. have been, for ſimilar pur-ſes, claimed by the Sovereign. In Germany, the peo-have been obliged, by the different military Govern-nts, to form walls of unctuous earth mixed with ſtraw, the natural production of Salt-petre. All matters af-ding azote, if expoſed in natural decompoſition, to the of oxygen from the atmoſphere, naturally afford ous gas and nitrous acid: And the preſence of ſolid ſa-e matters, ſuch as lime, pot-aſh, ſoda,—attracts that rous gas or acid into new combinations,—and thus lds nitre. The atmoſphere, being a grand reſervoir of te as well as of oxygen,—and being often in ſtates in ich theſe matters tend to unite in the formation of ni-us gas;—hence, it unavoidably happens, that, wherever ances,—ſuch as old walls, &c. containing lime or pot-are long expoſed to the free acceſs of the air of the at-ſphere,—products of nitrous ſalts are obtained. In England, this very time, as well as in all other countries, the proceſſes rming ſalt-petre, in the way of a great manufacture, are holly directed to bring matters containing pot-aſh, into act, in a digeſtive ſtate, with atmoſpheric air with ex-ceſs

ceſs of azote. The calcareous ſoil of Spain, bei
poſed to the acceſs of the atmoſphere, affords, in
places, an ample annual produce of ſalt-petre. In
both nitrate of pot-aſh and calcareous nitrate are m
factured in vaſt quantities;—the former by the expoſi
vegetable aſhes to [illegible]eſs of air,—the latter by the
lar expoſure of a calcareous ſoil. The temperatures
climates of India and Spain, are more favourable tha
of theſe Northern climates, to the production o
petre; becauſe, they oftener contain that heat which
quiſite to favour the decompoſitions of the gas-oxyge
the gas-azote of which the baſes are to be united i
new ſalt Our great ſupply of nitre in Britain, has
been by importation from Hindooſtan. Between the
1763 and 1769 *incluſive*, not leſs than 247,689 cwt.
and 3 lb. of ſalt-petre was imported from India int
tain. Of this, were re-exported 47,010 cwt. 2 qrs
3 lb. The Dutch have, alſo, been accuſtomed to ſ
themſelves with ſalt-petre from India. About two-t
of all the ſalt-petre exported from Hindooſtan, go
China.

In the eſtabliſhment of artificial nitre-works in B
it might be proper to procure a greater heat, than
of the natural temperature of the climate.

The French have employed a variety of extraord
means, ſuch as the uſe of the pot-aſh, of cheſnuts,
in the manufacture of Nitre for their uſe in the cou
the preſent war.

The Salt petre now manufactured in Britain is of
quality than that from India; and is ſold at a rate of
1-11th higher than the price of the Ind

III.

Manufacture of Gunpowder.

1. Nature of Gunpowder.

UNPOWDER, an article of very extenſive manufac-
, and very ample conſumption, is a mixture of nitrate
ot-aſh or ſalt-petre with ſulphur and charcoal. It owes
etonating combuſtibility to the looſeneſs of the com-
tion of the oxygen with the pot-aſh in its nitre, to the
rdinary appetency of the ſulphur and charcoal for
en, to the neceſſary gazification of all the parts of
mixture, except the pot-aſh, and to the neceſſary tran-
s of light and caloric,—*firſt*, in the gazification of
xygen of the nitre,—and *ſecondly*, in the joint gazi-
ion and oxygenation of the ſulphur and the carbon.
ew compounds produced by the detonation of Gun-
der, are ſulphureous-acid-gas, carbonic acid, and car-
te of pot-aſh.

2. Invention and uſes of Gunpowder.

his compoſition was, firſt, invented—by whom, is un-
n,—in the progreſs of the thirteenth or fourteenth
ry. In the fourteenth century, it began to become
bject of manufacture in the great way, and to be ge-
ly uſed in thoſe which are called *Fire-arms*, in the
of War. Ever ſince that period, the uſe of fire-arms
of gunpowder has become more frequent and general
ar. The manufacture of gunpowder for this uſe, is
immenſe, throughout almoſt all parts of the world.
powder is, alſo, uſed in quarrying and mining, for
ing or *blaſting* rocks, and for a diverſity of other pur-
in the Arts.

In

3. Proportions of the materials in Gunpowder.

In the manufacture of gun-powder, charcoal, ſu and nitre, of the beſt quality of which they can b cured with convenience, and at a cheap price,—are, rately, reduced to a coarſe powder, then mingled tog ground down, and pounded to extreme fineneſs.— following table exhibits the proportions in which i been uſual to mi e materials, in the manufactu the gun-powder ifferent countries ſpecified.

England.			Sweden.	Poland.	Ital
Saltpetre	75		75	80	
Sulphur	15		16	12	
Charcoal	10		9	8	
	100		100	100	

Later experiments made by the French Chemiſts preſent by their reſults,—the beſt proportions to 80lb. of Saltpetre, 15lb. of Charcoal, 5lb. of ſul After theſe mixed materials have been reduced to a almoſt impalpable powder; the powder is then moiſ with water, and granulated—by making it paſs, w moiſt, through a fine ſieve After the granulation, it be dried by the heat of the ſun, or in ſtoves heate great iron pots. If this powder remains in any de moiſt, it will not exhibit the due briſkneſs of explo and detonation. It is a common fraud with the m facturers of gun-powder, to mix their ſaltpetre with c mon ſalt, and to uſe ſea-water in moiſtening it, by w the expence of the manufacturer, may be ſomewh miniſhed, but the quality of the article ſuffers a c derable deterioration.

iſhments of this manufacture, are ſufficiently
throughout Britain.

IV.

Manufacture of Soap.

1. Nature of Soap.

, one of the moſt common and uſeful productions
hemical Arts, is a combination of OIL from ani-
vegetables, concrete or fluid, with SODA or POT-
d a certain proportion of Lime. The mixture of
potaſh, affords thoſe which are called *ſoft ſoaps*:
ture of *Soda* with moſt *Oils*, affords *Hard Soaps*.
Soda employed may be either that from *Barilla* or
n the Scottiſh and Iriſh *Kelp*. It ſhould be in a
the higheſt poſſible purity.

2. Materials of which it is made.

otaſh will be that from vegetable aſhes, ſlightly
to drive off whatever contaminating, combuſtible
ay ſtill remain in it.
Olives,—animal fat or *tallow*,—*hog's lard*,—oil
mal excrements,—oil from *whales* and *herrings*,
ſome *leſs fixed* vegetable oils, are, all, ſuſceptible
employed in the manufacture of Soap. The leſs
etable oils tend, even with Soda, to form, rather
hard Soap.
is employed, on account of its extraordinary
of affinity to the carbonic acid. The ſoda of
ce is always carbonated. Lime, abſtracting the
carbonic

carbonic acid, reduces the ſoda to that cauſticity in which alone, it can enter into the proper ſaponaceous combination with oils.

Sea ſalt is often added in a certain proportion, to the lixivium, in the preparation of *Hard Soap*. This addition, however, is not eſſentially neceſſary; It has been made by perſons who carried on the practice, without underſtanding the ratio of their art.

2. Commencement of the manufacturing proceſs.

With theſe materials, let the intention of the manufacturer, be, to prepare 1,000lb. of ſoap; He muſt proceed, as follows:

Firſt, let him prepare a veſſel of *white* wood,—or it may be a *reſervoir* of bricks cemented and plaiſtered with lime,—for the firſt mixture of his materials. At the bottom, this reſervoir muſt have a ſieve-like opening, by which the lixivium may paſs, without its impurities, into a *channel*, prepared to conduct it into the *boiler*. The boiler is, at the bottom, of metal,—but above, rather of bricks cemented and covered with plaiſter of lime. If *cauldrons* of caſt iron can be conveniently procured, of ſufficient capacity; perhaps theſe might, more uſefully than the former ſort of veſſel, be employed in this manufacture. *Moulds* of wood or ſtone, are likewiſe to be provided, for the reception of the ſoap from the cauldrons. Theſe may be of any ſize,—according as you deſire to prepare your pieces of ſoap for the convenience of the market. It will be neceſſary to have, alſo, an *areometer*, by which you may aſcertain the ſtrength of the lixivium,—with inſtruments for pounding the ſoda, ſtirring the uncongealed Soap, cutting the Soap into ſmall pieces, &c.

Thus provided with implements, let the manufacturer then pound his *ſoda* to the fineneſs of unmixed ſand.

e. then, for your [illegible] of required [illegible]. [illegible] [illegible]

lves, [illegible] Soda [illegible] quick-lime. Slake the

th a little water. Sift it. Mix the lime and the

At the bottom of your reservoir, spread a cloth to

a strainer of the lixivium. Pour water in such

y, that it may thoroughly moisten them all, and

ven cover it over, to the depth of two or three

s breadths.

4. The [illegible] lye.

r theſe matters have been left to macerate for the f a few hours. Diſcharge the lixivium by the cock bottom of the reservoir, of which cock the inner or muſt be covered with a cloth, to act as a ſtrainer of . The liquor which now flows off, is the firſt lixivium. It is to be ſet apart in a ſeparate veſſel. the firſt lixivium is entirely drained off,—but the pour in a new quantity of water into the reſervoir: he mixture to ſtand thus for a few hours; then e cock, and ſuffer this ſecond lixivium to flow off re. You may, then, in the ſame manner, take off lye.

5. Mixture of the lye and the oil.

n theſe Lixivia are thus prepared; the next part of ceſs, is, to put your oil into the boiler or cauldron. add to it,—firſt, your third lixivium, gradually,— he *ſecond*,—and, at laſt, a part of the *firſt* lixivium, in ſucceſſive portions, each portion, but of ſmall y. During all this time, a boiling heat is to be p in the cauldron. Even after all the portions of erent lixivia ſhall have been poured in; the fire ſtill, for ſome time, kept up.—Then add a few of *common ſalt*. The liquor will, upon this, aſ- ill more and more of a thick, paſty, granulous ncy. Maintain the fire under it, for a couple of

Book IX. Chap. IV. of hours longer. Let the fire and [illegible]
be entirely removed. Ceaſe from the ſtirring
ture which muſt have been hitherto, [illegible]
After a few hours cooling, a *ſoapy*
exhibit itſelf at the ſurface of the matter
Under it will remain a *coloured liquor* which
drawn off by a cock in the boiler, and to be
uſe as a lixivium in the preparation of the
make.

6. Formation of the Soap. After this liquor is drawn off;—the fire is
under the boiler;—a ſmall portion of water
is to be poured in;—the maſs of ſoap,
this addition, is to be again liquefied, and
ebullition. This ſecond boiling is to be
the ſtate of the *ſoap*, is to be, from time to
the cooling of a portion taken out, upon a
—till the whole ſhall at laſt appear to have
conſiſtency and aſpect of good *Soap*. The
to be removed,—the ſoap to be cooled,—and
beneath, to be drawn off by a cock, as
new portion of the beſt lixivium, is, now,
added;—the fire is to be renewed;—and the
is to be, now, continued—till the *ſoap* ſhall
acquired the perfect conſiſtency which
to it. It is, then, to be ſuffered to cool a
from the boiler, to be poured into the moulds
to form it for the purpoſes of commerce. At
of each mould, it is uſual to put a ſmall quantity
of pulverization. The ſoap may either be drawn
the mould by the cock in the boiler, or taken
ladles. After ſtanding in the moulds for
days, in winter,—or, in ſummer, for ſome days

o be cut into ſquares for ſale.—The *marble*
owes its diverſity of colours to *black* and *red*
, which are intermingled, in the preparation
ommon for the manufacturers to make up
ith too much water, and too little oil. This
t frothe ſo well, nor go ſo far in waſhing, as
more honeſtly prepared. The *marbled Soap*
er, and contains leſs water, than the *white*
f ſweet almonds, affords, by a ſomewhat
preparation, almoſt as good hard *Soap*, as

he ſubſtance uſually employed, inſtead of *oil*, 7. Soap of Tallow.
cture of *ſoap*, in Britain. In the manufac-
low, the lixivia may be added to it, in the
leſs of ſlowneſs and delicate preparation than
olives is employed. The ſuperior fixity of
s its combination with Soda, ſomewhat more
an is that of *oil of olives*.
s in uſe, in Britain, as an ingredient in the 8. Soap of Fiſh Oil
of *Soap*. The *Soaps* which *it affords* are not
ſagreeable ſmell, and are not of a ſufficiently
ncy. But, this oil might be purified, ſo as
Soda, Soaps of much better quality.
ployed inſtead of ſoda, in all this train of 9. Soap of Potaſh.
ords, ſtill, only *ſoft Soap* to which no cool-
a hard conſiſtency. The addition, however,
of Soda, or even of *muriate of Soda*, in
ntity, will produce the effect of conſolidating
that is made with potaſh. The knowledge
is of ſome importance, as potaſh is often
ed at a cheaper rate, than Soda of equal

10. Cold proceſs for making Soap.

It is alſo poſſible to prepare Soap without any con rable conſumption of fuel, by mechanical mixture, natural evaporation, in a climate of warm tempera But, with *tallow*, this is not eaſily poſſible. Even oil, the cold proceſs is not the moſt profitable one.

11. Impure Soaps.

Additions of alum, ſea-ſalt, ſtarch, lime, pulve ſoda, oil, tallow, and water, are employed in a villai manufacture by which it is ſaid, that 100lb. may be mented at ſmall coſt to 400lb. for the market. The tice is baſe; and the Soap thus produced, is unfit for good purpoſe. Good new hard Soap contains ſome more than $\frac{1}{2}$ of oil; nearly $\frac{1}{3}$ of water, and ſoda fo reſt of its compoſition.

12. Cheap Saponaceous Lye.

It is poſſible to prepare, at no conſiderable expen *ſaponaceous lye*, which, in waſhing, ſhall anſwer almo the purpoſes of good *hard Soap*.

Take any quantity of well burnt aſhes, of heavy wood. Mix with theſe, a few handfuls of newly ſlaked. Add water; and boil the whole a lixivium. Then leave the lixivium at reſt, till thoſ traneous matters which cannot enter into it, ſhall been depoſited at the bottom, or thrown to the ſurfa be ſkimmed off. Then draw off the pure lixivium. to it, oil to about a thirtieth or fortieth part of its quantity. The mixture will be—a liquor white as capable of frothing—like *Soap Water*, and in dil with water, *perfectly* fit to communicate *ſufficient* w neſs to Linens. This *liquor* may be prepared from W aſhes of all ſorts, and from rancid greaſe, oil, or b It is, *therefore*, highly worthy of the attention of an nomical houſewife. When the aſhes are ſuſpected

deficient in alkali, a ſmall addition of pulverized Bo Sei
ſoda, may be made to the lixivium.
tio of theſe whole proceſſes, is eminently beau-
da, potaſh, and pure quicklime are incombuſ- Rat mat
ances : Oils and tallows of all ſorts, are highly ot S
le. The three former ſubſtances have a very
tency *for* combination with all combuſtible ſub-
The latter have conſiderable tendency to enter
with ſuch as are oxygenous and incombuſtible.
ination of the qualities of the two is requiſite to
at detergency of contaminating ſubſtances, both
le and incombuſtible which we require in waſh-
lmoſt all contaminations to be waſhed away,
ſe two claſſes. The combination of an oil with
is known to *afford* the wiſhed for detergent
their qualities. Hence the deſire to combine
oap. The whole proceſſes of *Soap-making*, are
o *effect* the deſired combination in the moſt *per-*
ner. Lime is mixed with the Soda or potaſh, in
letach the carbonic acid which always neutra-
lkali of commerce. The Soda or potaſh, and
are lixiviated, in order to bring them into that
al comminution of parts, which is requiſite to
e re-actions between the elementary particles of
, and thoſe of the oil or tallow. A weak lixi-
rſt added to the oil ; becauſe in the weak lixi-
re is a finer attenuation of the parts of the al-
e lixivium is added *gradually*, and in ſmall por-
cauſe, if added more largely and at once, it
duce a mixture, without adequate combination,—
s, might occaſion a volatilization or combuſtion
It is repeatedly brought to congelation and

then again melted, in order to produce the moſt pe union of all the particles of oil and alkali, and to fr as much as poſſible from all ſuperfluous moiſture. not true, as is ſuppoſed, that the lime is ever entirely miſſed from the compoſition. Lime ſtill remains, tains in it a proportion of water, and when the comes to be uſed in waſhing, favours its frothing, by ſtrong attraction of carbonic acid from the atmoſph *Boiling heat* is neceſſary in effecting this combina becauſe it attenuates the parts of the matters to be c bined, and brings them into mutual contact. *Stirri* neceſſary for a ſimilar reaſon.

V.

Manufacture of Glaſs.

1. Importance of this manufacture.

GLASS is one of the moſt uſeful of all the combi tions formed by the union of mineral ſubſtances. ingredients are *Soda* or *Potaſh* and *Silice*. Its invent was by the Ancients, on the Eaſtern coaſts of Mediterranean Sea. They uſed it for ornamental p poſes, but neither for windows, nor for looking-gla It was manufactured chiefly in Italy and Spain, in earlier ages of the hiſtory of Modern Europe. *Vene Glaſs* and *Venetian Windows*,—in conſequence of great manufactures of *Glaſs* of all ſorts, which ancie ſubſiſted at Venice, and furniſhed ſupplies

ity to all Europe,—are ſtill famous in every European
try. From the Southern countries of Europe, the
manufacture of Glaſs was, transferred to the middle
to the Northern regions. It was early in the laſt
ury, ambitiouſly carried on, in France, for the pur-
s of regal luxury and ſplendour. It now flouriſhes
nſively in Britain,—at Newcaſtle, at Liverpool, at
h, Dunbarton, and in many other places. Even in
way, *Glaſs-works* have been, within theſe laſt twenty
rs, very advantageouſly eſtabliſhed. The following
the objects which require the principal attention, in
manufacture of *Glaſs.*

2. Furnaces and pots.

. For the conſtruction of the furnaces and crucibles,
argillaceous earths, in the ſtate of fine white clay, free
m all mixture of metallic oxydes, calcareous ſalts, bi-
inous contaminations, and even without any very
ge proportion of ſiliceous matter in them. Let this
terial be ſo refractory againſt fire, as to be in no dan-
of fuſion from the vitrifying heat to which it is to
expoſed: And let it poſſeſs that tenacity and ductility
ich are neceſſary to make it aſſume, without ſhrink-
and cracking, the required forms. The *fuſing fur-*
e may, properly enough, be rendered, in ſome parts,
a poroſity adapted for the tranſmiſſion of moiſture.
t, the *crucibles* ſhould be formed of clay highly *ductile*
d *tenacious.* The *clay* for the furnaces, is baked care-
ly into ſuitable bricks: And the drying of theſe bricks
ſuch a manner as to preſerve to them the requiſite
alities, is a matter, at once, of the utmoſt nicety, and
e greateſt importance. The formation of the *pots* or
cibles, is, alſo, a matter of extreme delicacy in execu-
on. But, it is impoſſible to enter here into a detail of

the proceſs. The ſpherical form appears from t periments of *Loyſel* and others, to be the moſt adv ous for the furnaces.

3. Materials for vitrification.

2. After the preparation of the *furnaces*, it ma be proper to ſelect the materials for vitrification. pureſt quartzoſe ſand is the ſtony matter to be p for this end. *Waſhing* clears it of earth. And *roa* a red heat will carry away any combuſtible matte which it may be intermingled.

The two *metallic* ſubſtances which are the moſ monly employed as fluxes to bring this pure ſiliceo into vitreous fuſion, are *minium* or *red lead*, and a The former is, for many reaſons, preferable; i better, that the latter ſhould fall entirely into diſuſe.

Potaſh and *Soda* are the alkaline ſubſtances em in the fabrication of *Glaſs*. *Soda* is preferable, as brought the moſt readily into fuſion, together w ſiliceous ſand; but, *potaſh* being ſometimes chea alſo much employed. To purify the *ſoda* of *bar* *kelp* from the impurities with which it is, in theſ poſitions mixed,—as well as to extract the So this or other uſes, from muriate of ſoda or comm —a mixture of *charcoal*, of *lime*, or of *oxyde* o or oxyde of lead, may be mixed in a due heat, w barilla, kelp, or ſea-ſalt which is to be employed. ate of lime, muriate of iron, muriate of lead, carbon are, on the one hand, reſpectively, the reſults of th ture; And, on the other, you obtain the *ſoda* which may be cryſtallized by lixiviation, and ſ evaporation. Aſhes from vegetables, and from works, however cheap and vile, if mingled with and lixiviated, are capable of affording either ple, for the manufacture of *Glaſs*. *Lime* is even ſuſ- ptible of being advantageouſly mingled in the vitrifiable mixture, of which the *Glaſs* is about to be formed. A ood mixture of this ſort, may be produced by the addi- ti of 10 or 15lb, of Lime to 100lb. of Soda or potaſh, nd from 200 to 220lb. of the ſiliceous earth. *Lime* as a tendency to make the *Glaſs* leſs liable than it would therwiſe [illegible] to attract moiſture from the atmoſphere: ut, it ſhould be well-burnt quicklime;—otherwiſe, it ill be apt to ſpoil the *Glaſs* into which it enters, by its ntinual tendency to give out carbonic acid. To pre- nt its acting with a vitrifying power upon the pots or cibles,—it is uſual to add together with lime, in the [illegible] ure of Glaſs for bottles, a moderate quantity of gillaceous earth. But, as this earth tends always to give green colour to the glaſs into the compoſition of which enters; it is to be uſed only in the making of glaſs for ttles. *Kelp* or *barilla* may even be uſed without much evious purification in the fabrication of glaſs, if a ſufficient antity of lime be added to diſengage its acid and other purities, in the beginning of the proceſs.—It ſhould em that, however, one of the cheapeſt proceſſes for ocuring Soda from ſea-ſalt, is that of Mr. *Birnie* of ith; who oxydates lead by an intenſity of heat that de- ches this oxyde from the metallic ſilver with which it s in the firſt maſs, intermingled;—mingling the oxy- ted lead with ſea-ſalt, thus produces a muriate of lead ith lixiviable ſoda in a ſeparate ſtate;—adding to the uriate of lead, a ſufficient proportion of quicklime, pro- uces muriate of lime and metallic lead;—and then ſends e muriate of lime to be employed in bleaching,—while e lead is now fit for all the uſes of the pure metal.

4. Application of fuel.

3. Having prepared your furnaces and pots,—
having made a ſufficient proviſion of the pure ſilic
ſand, the alkali, the lime, or the metallic fluxes and
argilla, which are to be employed in the manufactur
the next object is, to employ an adequate heat. Th
to be accompliſhed by due intenſity of fire, by the
of the furnaces, tending to concenter the heat into a f
and by the greater or ſmaller quantity of freſh air a
ted into contact with the fire, Except for dark-colo
glaſſes,—wood, coaks, or charcoal, not bituminous
coal, ought to be employed as fewel.

Beſide the proper materials and the fewel,—*nitr*
oxyde of manganeſe,—the latter with caution.—are
employed in order to purify the glaſs which you pre
and to free it from any colouring which it might o
wiſe derive from the combuſtible matters uſed in its
paration.

5. Purifying calcination.

4. The firſt concern, now, is, to calcine or hea
tenſely,—to drive off impurities,—both the alkali an
ſileceous ſand,—each by itſelf. In this calcination o
alkali, earthen veſſels are reckoned the moſt proper to
tain it during the operation,—becauſe theſe do not re
communicate any diſcolouring contamination.

6. Second calcination.

5. The materials are, then mixed, and ſubjected
new calcination, the object of which, is principall
drive off any carbonaceous impurities which migh
remain among them. It is, likewiſe, uſeful to pro
that thorough intermixture of the alkali with ſand, w
is requiſite to make the next part of the proceſs
place with due advantages. This operation is not
formed in the grand fuſing furnace, but in other ſm
furnaces adjacent to it.

7. Fuſion into glaſs.

6. The matters thus intermingled and freed from all extraneous mixture, are to be put into the fuſing furnace. They fill the pots. But, they ſhould be put in, gradually, in order, that the preſence of ſo much colder matter, and the cooling produced during the labour of the operation, may not too much and too ſuddenly diminiſh the proper furnace-heat. After the firſt portion of the matter has been put into the pots, it is then neceſſary to await,—till all the fumes of the diſſipation of the ſuperfluous alkali ſhall have been evaporated,—and till the liquid glaſs ſhall appear, upon trial, to be internally free from bubbles of burſting gas. Then; ſucceſſively, add, at three or four intervals, the reſt of the prepared materials; awaiting, after each new addition, till the ſuperfluous alkali ſhall have been entirely diſſipated. The ſame proceſs may be carried on, either for all the pots together, or elſe for only one-half or any other proportion of thoſe which you have ready in the furnace. In this laſt caſe, while the glaſs is taken from the one-half to be blown,—it will be only in a progreſs of fuſion, in the others.

8. Mechanical parts of the operation.

7. The mechanical operation of *blowing* the *Glaſs*, or *ſpreading* it in plates,—ſucceeds.

9. Remedy of bad blowing.

8. It ſometimes happens, that *Glaſſes* are blown too thick, and cool unequally at the different ſides. In theſe caſes, the proceſs of heating the Glaſs a ſecond time in a red heat, and cooling it by ſlow degrees, is neceſſary to communicate the deſired uniformity and ſtrength. If this be neglected; the *Glaſs* will be apt to break when it is ſubmitted to cutting; or even any very moderate heat.

10. Imperfections in the ſtructure of glaſs.

8. *Glaſſes* are ſubject to various apparent imperfections in their ſtructure.—When the materials have not been thoroughly intermingled in the furnace, but as it were,

applied to one another in ſeparate layers; then the Glaſs produced, is apt to exhibit a *ſtriated* appearance.—Sometimes, the *glaſs* is marked with *green ſtreaks* which owe their origin to portions of argillaceous earth.—It has, in other inſtances, the appearance of containing tears. Theſe are owing to particles of allumine from the corroſion of the pots. *Glaſſes* containing theſe *tears*, are exceedingly ſubject to break. Some glaſſes exhibits *knots* or *aſperities* on their ſurface, produced by the too ſudden cooling of a portion of the Glaſs in the manufacture.—*Bubbles* appearing in *Glaſſes* afford a proof, that they were made with too little refining, with too faint a heat, or with the employment of too ſmall a proportion of the fluxes.—*Large knots* appearing in glaſs, muſt have been produced by grains of ſand, or by that ſaline combination which is formed during the fuſion of glaſs, and bears the name of *Salt of Glaſs*.

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11. **Pottery.**

POTTERY of all ſorts, from the coarſeſt brown pitcher, to the fineſt *porcelain* is prepared by a chemical manufacture not very unlike to that of *Glaſs*. For this compoſition, there is to be taken a clay compoſed of a mixture of ſiliceous and aluminous earth, but without any calcareous mixture. It ſhould be purified as much as poſſible from ſand or gravel, and from all contamination by metallic, or other combuſtible matters. It is to be wrought and attenuated, in order to encreaſe its fineneſs, conſiſtency, and tenacity. That which is called *porcelain earth*, is procured by the pulverization of rocks of an aluminous and ſiliceous mixture. It is kneaded and wrought to the proper tenacity with the help of water. It is next to be formed with moulds, into thoſe various utenſils which are to be fabricated of it. After receiving theſe forms, the ks are then to be painted—if painting be thought eſſary, and to be expoſed, for a ſufficient length of time t due intenſity of furnace heat. The ſubſtances which r. Wedgewood of Staffordſhire employs in the en- uſtic painting on the beautiful earthen-ware of his ma- facture, are a compoſition of a white earth from oree in North America, with metallic oxydes of va- us colours, and a nitrous ſalt. Theſe mixtures are re- ced by grinding with oil of turpentine, into the ſtate of aint. They are then laid upon the veſſel, agreeably to painter's deſign. A great diverſity of colours is thus to obtained. In other caſes, figures of *baſſo relievo* of the moſt gant deſign, are cut upon theſe veſſels with the graver. e veſſels are then expoſed to an intenſe furnace heat. The nt is fixed with encauſtic force in a vitrified form on ſurfaces of the veſſels. The aluminous mixture aſ- nes under the action of the heat, its utmoſt condenſa- n, hardneſs and tenacity. The veſſels are fitted by ſlow oling for uſe. In common caſes, it may be ſufficient to ify the exterior ſurfaces of the coarſeſt earthen ware ſcattering upon it, a little muriate of ſoda. Some of moſt beautiful of Wedgewood's earthen-ware, is, at ſt partially, without painting or vitrificaion. The ice and proportions of the materials, their ſufficient pu- cation, attenuation and mixture, the elegance of the ulds, the beauty and perfection of the relievos or the uſtic painting, the intenſity of the heat, its thorough etration of the veſſels, the ſlowneſs of the cooling &c. the circumſtances upon which the perfection of this nufacture appears to depend.

The manufacture of Bricks is a coarſer ſpecies of the e chemical Art. 12. Bricks.

Preparation

Book IX. Sect. IV.

VI.

Preparation of Cements and Plaſters.

1. Lime hardens with water.

LIME poſſeſſes, among other remarkable properties,
of hardening in combination with water, inſtead of b
like ſo many other ſubſtances, liable to be diſſolved
water. It, alſo, has the quality of hardening much m
perfectly and to a much more refractory aggrega
when it is mingled with ſiliceous earth, than while
combined with water only.

2. Its power of cementation.

Theſe two properties fit it for forming a cement a
connect ſtones and bricks in buildings with a junction
unlike to that of the different ſtrata of a natural rock.

3. Mortar.

Any common mixture of *Alumina* and *Silice* with *L*
makes that ſort of *dry or earthy mortar* uſed, in many pa
this and other countries, in the conſtruction of the cott
Lime burnt from rocks or ſhells, and then ſlaked with
ter, is mingled with ſand of conſiderable coarſeneſs,
with as much water as the Lime and Sand can abſorb
the ordinary manufacture of mortar for the purpoſe
cementation. The Lime, the Sand and the Water
quire to be very much wrought together, in order to
duce that intimate mixture and combination of the
their minuteſt particles, without which the mortar ca
poſſibly, be eminently excellent.

4. Mortar of the ancient Romans.

The remains of ancient Roman Architecture, exhi
calcareous mortar which has hardened to rocky agg
tion, and which, time, and expoſure to air and water,

to have rendered only more refractorily tenacious and l, inſtead of diſſolving it. It was fancied, that this *nt of the Ancients* had been formed by ſome peculiar t that was now to be numbered among the loſt inven- ; and many attempts were made to re-diſcover it,— r with ſatisfactory ſucceſs,--yet, not without pro- ng ſome improvement in the accuſtomed preparation lcareous cement.

5.
Origin of the peculiar hardneſs of the mortar in old buildings.

t, in truth, though the Ancients certainly muſt have red their calcareous mortars with great ſkill and care ; was no ſuch myſterious ſecret in the matter, as ſome been pleaſed to fancy. The effect of time and of ral qualities and relations, has, in this inſtance, been ken for an effect of human ſkill. The cement in alls of all the Gothic Caſtles, the works of the Dark , when the Architectural ſkill of the Greeks and ans, no longer remained, appears to poſſeſs the ſame conſiſtency,--harder and more tenacious, than that of ement in our modern buildings,—which is diſcovered cements of the ancient Roman works. The whole doubt, effected by the natural operation of cauſes endent of man,—acting upon a calcareous mortar ally prepared with a reaſonable degree of care and The water enters into intimate union in a ſaturating rtion with the lime, in the courſe of their remain- ng together. The continual abſorption of water and nic acid from the atmoſphere tends to form the cement ne homogeneous conſiſtency, at leaſt at the exte- arts. The preſſure of the weight of building under it commonly lies, brings it ſtill more and more nion with the intermingled ſiliceous ſand. And it is by by the operation of all theſe cauſes, with perhaps many other finer and more ſecret ones, that its perfect rocky aggregration is,—only in the lapſe of ages, accompliſhed.

6. Dr. Higgins's mortar and plaiſter.

In the year 1779, Doctor Bryan Higgins, then of London, now Profeſſor of Chemiſtry under the Inſtitution of the Royal Iriſh Academy in Dublin obtained the uſual Letters Patent for the excluſive compoſition and ſale of a particular cement his own Invention, to be uſed in building, repairing, and plaiſtering walls.

Pure ſiliceous ſand that has not been water-worn, is, *for this compoſition*, waſhed, ſifted in a ſieve which ſhall tranſmit all grains that do not exceed in diameter one ſixteenth part of an inch,—and expoſed in the ſifting to a flow of clear water that ſhall carry away all ſoft extraneous matter, while the pure ſand which paſſes through the ſieve, falls into a proper receptacle.- Thus purified by a *firſt* ſifting, the ſand which has ſubſided into the receptacle, is to be, *next*, farther cleanſed by a ſecond waſhing in clear ſtreaming water, and in a ſieve that ſhall tranſmit only grains of which the diameter does not exceed one-thirtieth part of an inch. That ſand which, at this time, paſſes through the ſieve, is to be received, as before, into a proper receptacle; and is the *fineſt ſand*: That which remains on the ſieve is to be preſerved apart, as the *coarſer ſand*. Theſe manipulations may be renewed, till any required quantity of ſand is thus prepared. The two different ſorts of ſand are to be ſeparately dried, either on an iron plate in a furnace, or in the Sun.—So much for the ſand.

The *Lime* is *next*, to be prepared. Let that which you uſe, be the pureſt and moſt cauſtic *ſtone-lime*, that you can

eaſily

aſily procure,—ſuch as is little contaminated with clay, ypſeous matter, or any ore of iron, that has been recently repared, has been kept from the carbonating acceſs of ir, and is ſoluble in acetous acid with the leaſt effereſcence. Put to the quantity of 14lb. of this lime, at nce, into as fine a ſieve of braſs-wire, as you can procure. lunge the ſieve with the lime into a butt of ſoft water, raw it quickly out; immerſe it, after a little, for a ſeond time; continue this till the Lime be entirely ſlacked, —and till there paſs, at length through the ſieve into the utt, to the quantity of an ounce of the lime to every part of water in the veſſel. Let the Lime-Water thus ormed, ſtand in the butt, till it ſhall become clear. Then raw it off by wooden cocks, one ſtill a little lower than nother, as faſt as the lime ſubſides, and to the top of the lid lime at the bottom. This lime-water, Dr. Higgins alls his cementing liquor.—With it, then ſlake—to the antity of fifty-ſix pounds of the lime of the ſame quality that which you have already uſed. Sift this lime thus aked in the braſs-wire ſieve: and when it is ſifted,— t it either be kept in veſſels excluding the air, or elſe ed immediately.

A quantity of fine aſhes is next to be prepared by inding down the whiteſt burnt bones that can be proured, and ſifting the ground matter to the greateſt eneſs.

Take near 56lb. of the coarſe ſand, and 42lb of the fine nd. Mix them on a ſurface of hard wood. Spread the nd, ſo that it may ſtand in a ſtratum of the depth of ſix ches. Wet it with the Lime-water or *cementing liquor.* d 14lb. of the pure ſlaked lime in ſucceſſive portions, mix e lime thoroughly with the ſand, and beat them together with

with the inſtruments with which mortar is uſually made. Add, next, in ſucceſſive portions 14lb. of the bone-aſhes; and thoroughly mix and beat the whole, with as much quickneſs in the operation, as may be poſſible.—The mixture thus formed, is what the Doctor calls his *water-cement coarſe-grained*. It is now fit for uſe in building, pointing, plaiſtering, ſtuccoing. It ought to be laid on quickly, and the materials uſed with it, ought to be all wetted with the *cementing-liquor*. For a *fine grained cement*, only the *fine ſand* is to be uſed. When the mortar is wanted, of a coarſer quality, and at a leſs expence, well-waſhed coarſe ſand or ſhingle may be uſed, with a proportion of the fine ſand. When the mortar is to plaiſter, *tarras* muſt be added to it, inſtead of 2-thirds of the bone aſhes. The *cementing-liquor* may be made to ſoak into the work,—if the quality of the mortar be otherwiſe leſs perfect. For inſide plaiſtering, hair is mixed with this cement. For the purpoſes for which it was propoſed, this is certainly a very excellent preparation.

7. Dr. Williams's cement.

Dr. *Williams* of London, in the year 1780, made known the compoſition of a *ſtucco*, of which 110lb. are to be prepared by the admixture of 4lb. of pure *caſeous matter* from milk, 12lb. lime finely prepared and ſufficiently cauſtic, 84lb. ſand, fine, and well-cleared, with 10lb. of water.

8. Perfection of plaiſter.

The perfection of *plaiſter* in general, of whatever ſort, appears to depend on the formation in it—of a completely ſaturated combination of lime with water,—on a thorough mixture of the minuteſt particles into which the lime can be divided with the minuteſt correſponding particles of pure ſilice,—on the preſence of a certain proportion of larger ſiliceous grains to ſerve as mechanical baſis

for

[illegible] the other parts of the maſs,—and on the excluſion to [illegible] greateſt degree poſſible, of that carbonic acid, which [illegible] continually to enter into eager union with Lime.—[illegible] pure *caſeous matter* from milk, may ſerve to improve [illegible] tenacity of the *plaiſter*, when the Lime is not ſufficiently mixed with the ſand, and is too much carbonated. —But, Dr. *Higgins*'s directions for the compoſition of mortar, are certainly among the beſt, that can poſſibly be propoſed. *Mortar* and *Cement* thus prepared, would, probably, in due length of time, acquire all the rocky conſiſtency of the calcareous cements of the Ancients.

VII.

Bleaching.

1. Ends of Bleaching.

Either naturally, or in the courſe of uſe, all the cloths and other ſimilar matters employed for the accommodation of human life, are liable to contain or acquire colours and contaminations from which it is deſireable to free them. The deterſion of ſuch colours and contaminations is called Bleaching. It is one of the moſt important of all the Chemical Arts. It is in continual exerciſe among mankind. Its more ſimple and ordinary mode however is—merely—Washing. Bleaching is washing more complex and laborious, and intended to remove matters by which the effect of ſimple washing, is reſiſted.

The ſuſtances to be bleached are uſually cloth
or thread of ſilk, flax, wool, and cotton,—compo
peculiar modifications—of hydrogen, carbon, and
with a ſmall proportion of oxygen.

2. Subſtances to be bleached.

The matters to be removed by BLEACHIN
uſually, reſins, oils, and metallic oxydes,—the two
compounds of hydrogen and carbon with, in reſin
or leſs of oxygen.

3. Matters to be removed by bleaching.

From the earlieſt times in the hiſtory of th
water, expoſed to the heat and light of the Sun
open atmoſphere, the natural magneſian and
reous mixtures, and the carbonated fixed alkalis
been the favourite ſubſtances employed to BLEAC
or diſcoloured threads and cloths. In Egypt, the c
famous for fine linen among the ancients, *Natron*
impure *Soda* was procured for BLEACHING, from
mous Egyptian lakes in which that ſubſtance ſtill ab
The Greeks and Romans uſed the well-known
earth. In every country, ancient or modern, th
ſubſtances in different ſtates of their exiſtence, hav
employed, as bleachers and detergents. Human uri
cow's dung have been added to them in the practice
own peaſantry.

4. Subſtances employed as detergents, among the Ancients.

In theſe later times, where BLEACHING has be
ercisſed in theſe countries, as a great branch of
facture; the BLEACHERS have employed chiefly w
with warm and cold water, boilings in alkaline lies,
ration in alkaline and acid ſteeps; expoſure to the
of light and heat in the atmoſphere, with mech
beatings and rubbings.

5. Detergents of modern bleaching.

Wool, is naturally contaminated only with anima
The ſtains which it accidentally receives, are rarely

6. Bleaching of Wool and Woollen Stuffs.

to be completely removed. Waſhing with water, with
, or with any alkaline lye, is, therefore, uſually ſuffi-
t to bring wools and woollen cloths to the utmoſt pu-
of natural colour of which they are ſuſceptible.
h or *tar* in commixture with *butter*, is, in cold climates,
lied upon the fleeces of ſheep, as an additional protec-
againſt the cold of winter. It enters into an intimacy
nion with the wool, and fixes upon it other contami-
ng matters, ſo cloſely, that it becomes almoſt impoſ-
, without a very laborious proceſs of BLEACHING, to
ore to the wool, its primitive beauty of colour. The
e BLEACHING which ſucceeds in removing the
n from cotton or linen, will, alſo, remove it from theſe
ollens; but, not without great labour and difficulty.

inen and *flax* owe their natural green colour—
fly to a vegetable reſin which naturally exiſts in them.
intimately mixed in the filaments of the flax, and by
ſequence, in the threads and the whole texture of the
h. In order to diſſolve and remove it, the thread and
h require to be firſt opened in almoſt all their minuteſt
s, to the chemical action of the BLEACHING ſub-
ces to whoſe influence they are to be ſubjected. Next,
ſubſtances adapted to operate as ſolvents of the reſin,
ſt be applied in ſuch a manner as to act upon all the
s of the thread or cloth opened to their acceſs. *Laſtly*,
texture muſt be as little as poſſible, deſtroyed; and
e muſt be taken not to reduce the cloth by the
EACHING, into a ſtate in which it may have too great
endency to enter into new diſcolouring combinations.
ton, being likewiſe diſcoloured by a reſin, is to be freed
n it in the ſame manner as Linen and Flax: nor is
re any eſſential difference between the modes of

7.
Bleaching
of Linen
and Cotton:

BLEACHING required for theſe two ſubſtances. [illegible] *dreſſing* or vegetable *gluten* is put upon both cotton [illegible] linen threads in the weaving of them into cloth, in [illegible] to give ſmoothneſs and firmneſs of texture, ſuch as [illegible] ſufficiently endure the working of the loom. This, it [illegible] be removed in the commencement of BLEACHING. But it is ſoluble in hot water; and, therefore, is eaſily removed by boiling and waſhing.

8. Expenſiveneſs of Bleaching.

The ſubſequent proceſſes were till lately, extremely tedious, and required long labour, a great waſte of time, and an extraordinary conſumption of expenſive materials. The waſte of lime, alkali, acids, fewel, was very great. The price of the cloth was prodigiouſly enhanced by the expence of the BLEACHING.

9. Improvements in Bleaching, ariſing from the modern improvements in Chemiſtry.

Since the character of chemiſtry, has been ſo remarkably changed by the diſcoveries of Lavoiſier; ſignal improvements have been accompliſhed in the proceſſes of BLEACHING. It was underſtood, that Acids in general owed to their oxygen, their power of acting upon colours. It was ſoon diſcovered, that thoſe Acids in which the oxygen was liable to be the moſt eaſily detached from the baſe, had the greateſt energy in that deſtruction of colouring Reſins, which conſtitutes BLEACHING. Of them all, the oxygenated Muriatic Acid was found to perform this the moſt readily,—even with a force which, if not moderated, would almoſt entirely deſtroy the matters expoſed to its BLEACHING Action. The requiſite moderating of its enegy, was to be procured by the ſolution of the gas in water. The ſuper-oxygenation of the Acid was found to be the moſt eaſily practicable by expoſing oxyde of mangaueſe to the action of ordinary muriatic acid. The invention thus gradually improved, was at laſt fitted

ted for the uſe of actual BLEACHING. Berthollet, as
philoſophical chymiſt, M. Paget de Charmes, as a prac-
ſing bleacher, were thoſe who, in France, firſt taught
ow to bleach conveniently and ſucceſsfully with the
luted oxygenated muriatic acid. The proceſs of
erthollet was quickly made known by tranſlation, and
cceſsfully imitated, in Britain. The uſe of this diluted
uriatic acid, in alternation with boilings in ſolutions of
t-aſh, and with expoſure to the heat and light of the
n, in the open air, have been found by the moſt cau-
ous adopters of the improvement, to bleach without in-
ring the cloth, and to do it effectually, with a wonderful
ving of time. As a farther improvement, to ſave the
ſs of the acid which always took place in the moſt fru-
al mode of applying it, as well as to avoid that inconve-
ence to the workmen which ſtrongly aroſe in the former
ee application of the acid,—it was contrived to uſe in-
ead of the diluted oxygenated muriatic acid, an oxy-
uriate of pot-aſh, the uſe of which afforded all the ad-
ntages of that of the naked acid, with cheapneſs ſtill en-
eaſed, and with the moſt perfect convenience to thoſe
y whoſe toil it was to be applied. The uſe of this oxy-
uriate of pot-aſh, is now extenſive in both Britain and
eland. Mr. TENNANT taught to ſubſtitute oxy-muriate
f lime, as cheaper, and not leſs efficacious in its action,
an that of pot-aſh.

But we owe to the talents of Dr. HIGGINS, Chemiſt to
e Iriſh Linen Board, an improvement more recent than
y of thoſe above-mentioned, which affords ſtill greater
eapneſs, with equal whitening, in this important pro-
ſs of *bleaching*. Aware, that the mixtures of *ſulphur*
ith *ſoda* poſſeſſed detergent qualities of the moſt powerful

energy; and conſidering the ſimilarity of lime in many others of its energies to the fixed alkalis; he was led to believe, that *Sulphure* or *Sulphuret of Lime* might exhibit the ſame detergent qualities as *Sulphuret of Soda.* He made trial. A *Sulphuret of Lime* compoſed of 4lb. of Sulphur added to 20lb of lime, and this mixture diluted in 16 gallons of water, afforded a ſolution which anſwered as well, cold, as did the boiling ſolutions of oxy-muriate of pot-aſh. He has, therefore, recommended, that Linen, after being cleared of the weaver's dreſſing, ſhall be bleached by immerſing the cloth alternately in a ſolution of ſulphuret of lime, and a ſolution of oxy-muriate of Lime,—ſix times in each. His proceſs bleaches the Linen as thoroughly, and with leſs expence than any of the former proceſſes. *Lime* is cheap; *Sulphur* is not enormouſly dear: and when this cheapneſs of the ingredients, is added to the abbreviation of time and toil; certainly the inventor of ſuch an improvement, deſerves the moſt liberal, public, gratitude and praiſe.—Silks are ſuſceptible of being cleaned of the reſin and animal oil, upon the ſame principle of BLEACHING on which Linens are cleanſed.

10. Bleaching with Sulphuret of Lime and Oxy-muriate of Lime.

11. General Ratio of Bleaching.

As to the ratio of theſe proceſſes, the following things are evident. The ſubſtances to be diſcharged from Cloths in Bleaching being combuſtible, are to be diſſolved by incombuſtible ones: And ſurely nothing can be more probable than that Oxygen, Lime, Potaſh, and Soda, ſubſtances agreeing in combuſtibility, and in the ſame Bleaching energies, are, in their eſſential nature, but one common element. A great part of the proceſs of the BLEACHING conſiſts in bringing all the minuteſt particles of the reſin throughout the whole cloth into full contact

with

he particles of the oxygen, lime, or alkali.
.uſe of frequent boilings, of long expoſure in
ir, of watering, ſteeping, &c. Whenever the
is finiſhed, without the complete contact of all
having taken place between the cloth and the
matter,—the proceſs is imperfect. It is its ga-
ilty which renders gas-oxygen ſo much more
an ſolid or merely liquid ſubſtances to decom-
eſin of cloth. But, as the reſin to be taken
ompoſed of the ſame primary elements, with
nt that is to remain; there is danger leſt the
he lime, the alkali, while they decompoſe the
ay decompoſe alſo the latter. Sometimes, by
application, they do thoroughly deſtroy the
the filament; and it is then ſaid to be burnt in
HING. In other caſes, and theſe not uncommon
Bleaching, the cloth only has the proportion
iples ſo altered, that it is liable to be ſpeedily
after bleaching, by new attractions from the
, &c.

IX.

Dyeing.

1. Object of Dyeing.

Dyeing is a much more complex chemical Art, than that of Bleaching. Its object is—*to change the native colours of bodies, to induce new colours at our pleaſure, and render our artificial colours permanent upon the ſubſtances on which they are induced.*

2. Uncertainty of the Nature of Light and Colouring Matter.

If we were fully acquainted with the chemical nature and relations of *Light* and *Colouring Matter*; it might be eaſy to reduce the Art of Dyeing to an eſtabliſhment upon ſcientific principles. But, thoſe relations we do not certainly know. We know not, whether *Light*, in conſequence of a mechanical and chemical ſubdiviſion into its different rays, become the *Colouring Part* of all viſible ſubſtances, or whether *Colouring* be not rather like hardneſs or ſoftneſs, the reſult of the peculiar ſtructure of every different material ſurface, depending on no peculiar *Colouring Matter*, but ſimply requiring the medium of Light to enable it to act on the viſual organs of animals.

3. Theory of the Nature of Light.

Perhaps Light may deſerve to be regarded, merely, as *a Subſtance of peculiar relations and attractions, mechanical and chemical, which make it ſuſceptible of ſolution in fire, air, and water,—render it, in theſe ſolutions, excluſively capable of forming the medium of a ſenſible communication between the animal eye, and the ſurfaces of all other material bodies,—but enable it ſimply to tranſmit to the eye, the impreſſion of the mechanical and chemical ſtructure of the parts of thoſe ſurfaces,—while ſo far as its rays are,*

ſeparately,

ly, viſible, this is by virtue—only of the chemical and
cal ſtructure of their parts. If this be ſo; Light
e principle of Colour, but only the medium of
nication between Colour, and the human ſenſe.
ion in bodies, in this caſe, does not act, as giving
r to what would otherwiſe, be colourleſs, but, as
g a chemical change by which the ſtructures at
aces are altered. This view of the matter is not
But, it combines, in its favour, a greater num-
acts and analogies, than can be muſtered to re-
nd any other one. It differs from that which is
d in the Section upon Light, in the fourth Book
Work. It does not repreſent the priſmatic di-
f the rays of Light, as taking place ſo inceſſantly
there repreſented, in the operation of Colours.
len, we conſider the Colour as *ſimply the impreſ-*
he fine chemical, ſlightly influenced by the mechani-
cture,—whatever it is,—*of any ſurface, upon the*
Eye, through the medium of Light diſſolved in fire,
water; We ſhall infer the *Art of Dyeing* to be
a chemical Art, the principles of which Chemiſtry
e day, ſatisfactorily explain.—The following is a
f the preſent *Chemiſtry of Dyeing.*

4.
The Art of Dyeing, Chemical.

l, ſilk, cotton, linen are the ſubſtances upon which
manent colours are commonly attempted to be
Dyeing. Theſe ſubſtances tend naturally to re-
der ſome variety of the *White* colour. They
heir chemical compoſitions, compounds of azote,
n, and carbon, with often ſome ſmall proportion
n. They approach all, more or leſs to the *bitu-*
r the *oleaginous* character.

5.
Subſtances to be dyed.

Our

6.
Colouring Subſtances.

Our *Colouring Subſtances* are, chiefly—vegetal
tracts—metallic oxydes,—with ſome preparation
animal matters. Theſe are almoſt all, compo
hydrogen, oxygen, carbon, and azote, with differe
terrene or alkaline.

It is not difficult, to diffuſe the Colouring
mechanically, over the ſubſtances which we d
colour: Nor yet, even to unite the former with t
by ſlight chemical combinations.

7.
Difficulty of inducing permanent Colours.

But, it is extremely difficult to effect a combin
the Colouring ſubſtances with thoſe which we d
colour, ſuch as ſhall not be diſſolved by any c
chemical influences to which—cloths, for inſtanc
to be expoſed, during their ordinary uſe. For t
ſon, infinite pains and artifice are to be employed
ing. Nor is the ſucceſs of theſe pains and artifice
in any inſtance complete.

8.
General management of the Dyer.

To accompliſh its ends, the Art of Dyeing end
to imitate the Chemical Œconomy of Nature
elaboration of thoſe which are called the immedia
ciples of Animals and Vegetables. Like Nat
Dyer is obliged to attempt a great complexity of
cal compoſitions, and to add one compound to a
He has to diſcover—what colouring matters wi
municate the brighteſt and moſt diſtinct colours
will give the moſt permanent colours,—what a
ſubſtances will fix or even call forth a colour wl
principal Colouring Matter might not have, al
forded,—by what proceſſes of immerſion, boiling
ing, cooling, drying, &c. the combinations of I
may be the moſt completely accompliſh,
that, however other things be, one g

produced in Dyeing, is that of the moſt intimate
ct between every minute particle of the dyeing
ſtice, and every minute particle of the ſubſtance
h is to be dyed It is, likewiſe, to be allowed, that
oloration which cannot reſiſt every poſſible deſtroying
cy, may, however, be ſufficient, if it can with-
the action of air, water, atmoſpherical heat, and
ing with ſoaps.

9 *White*, not produced by dyeing.

HITE is ſo common in Nature, that we never try
oduce it in cloths, otherwiſe, than by Bleaching and
hing.

10. Dyeing of Blue.

LUE is dyed by the uſe of *Indigo*, the extract obtained
a plant of the ſame name, by means of infuſion, ſpon-
ous fermentation, churning, depoſition, the ſtraining of
epoſitum, and the formation of it into ſquare pieces
le. *Paſtel*, *Woad* or *Iſatis Tinctoria*, an *European*
, affords alſo a good Blue colouring matter; and
e preparation, its extract may even be made to yield
. But, the ſolution of either of theſe ſubſtances is
alone, capable of communicating a permanent Blue
r to cloths. In the dyeing of Blue with theſe
nces; it is uſual to mix 400lb. of paſtil, 30lb. of
20lb. of madder, 8 or 9lb. of lime, a quantity of
o varying from 10lb. to 30lb. with a baſket of bran;
ng in theſe matters at different times, and digeſting
for a number of hours in a ſtrong heat and in a
en vat; and then at length immerſing the ſub-
es to be dyed. When *indigo* alone, without paſtil,
e colouring matter; then a proportion of potaſh,
er, and bran are diſſolved, with the indigo; and the
e is digeſted over a ſlow fire, till it aſſume the re-
d blue colour. Silk, wool, linen, and cotton are,
alike,

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alike, dyed in indigo—baths, but with ſome variatio
the proportions of the ingredients and the advanceme
the proceſs. A ſolution of indigo in ſulphuric acid,
that which is called *Saxon Blue.*—*Pruſſian Blue* is
by the muriatic ſolution of *Pruſſiate of iron* or the ne
ſalt formed by the union of Iron with the Pruſſic
In all theſe caſes, the grand agents are oxygen, ca
with hydrogen, iron, and azote. The analyſis of in
proves it to be, for more than one-half of itſelf, com
of carbon: Its next principle is hydrogen: It has a
addition of oxygen: And it contains likewiſe, a
iron. It may be ſaid to partake of the characters of a
men, an acid, and a neutral ſalt. It ſeems to
chiefly to its iron and carbon, its power of afford
blue colour,—to its oxygen, the particular brillian
that colour. From the phœnomena of dyeing wi
digo, there ariſes no reaſon to induce us to think
there is any myſterious and peculiar colouring matt
duced in it, diſtinct from the reſt of the chemical c
ſition of the coloured body.

11. Dyeing of Black.

Black is induced—by boiling cloth which has
previouſly dyed *blue*, in a bath of Gallic Acid or
fuſion of Nut-Galls, for two hours,—keeping it f
hours more, without boiling, in a bath of logwoo
ſulphat of iron,—then waſhing and fulling it.
are various other methods of dyeing *Black*. This
of the ſimpleſt. Sumach is often uſed inſtead
galls. It ſhould ſeem that carbon and a neutral
iron are the principal cauſes in this proceſs,—by
the black colour is induced. In inducing a black
on ſilk, no previous blue is communicated. The
cleared of its natural gum. It is boiled in a bath

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and a quantity of ſulphate of iron is, in due time, duce the final precipitation of the Black Colour.

12. Dyeing of Red.

dder, the *Rubia tinctorum foliis ſenis* and the *Ru- regrina foliis quaternis*; the *cochineal inſect* which on the *nopal-plant* in Mexico; Kermes, the *coccus* an inſect which lives on the *quercus coccifera* in va- parts of Aſia, and in the South of Europe; *Gumlac,* oduction of a ſort of Ants, which they depoſite on nall branches of the *croton lacciferum,* in the Eaſt ; *Archil,* a paſte prepared from different lichens, owth of Europe; the flower of the *Carthamus tinc-* an annual plant cultivated in the South of Europe; coction of braſil-wood, the *cæſalpinia criſta,* and od, the *Hæmatoxylum Campechianum*; are the dif- ſubſtances employed to give a Red Colour to cloths uffs. *Scarlet* and *Crimſon* are the two moſt re- ble ſpecies of Red. The Colouring-matters are themſelves fixable upon Cloths. Recourſe muſt, re, be had to a very complex aſſemblage of affi-

Sulphate of alumine, tartareous acidulum, galls, ther vegetable aſtringents, *ſoda* and *potaſh, nitrous* riatic ſalts, acetic ſalts, &c. are employed as inter- te, the *mordants* or *baſes* of the dyers, to accompliſh manent fixation of the Colouring matters. The are numerous; and the ſeries of proceſſes at once and delicate. *Madder* with a proper baſe or t, is capable of communicating a good Red co- woollen cloths. The *Turkey* or *Adrianople* *cottons* is, alſo, derived from madder: but Euro- dyers have been little ſucceſsful in communicating the dye which is produced with a very complicated by the dyers of the countries on the Levant.

Scarlet.

Lac is, for different reaſons, prefe
ſame uſes. *Archil* gives to ſilks
colour. *Logwood* affords a *dark*-
with different matters, is capable
colours. The mixture of theſe diff
and the variation of the mordants
many different modifications of the
genation, the preſence of earthy
oxydes in greater quantities, wi
proportion of carbon,—and ſom
quiſite to effect the fixation of a
in dyeing blue and black.

13. Dyeing of Yellow.

A YELLOW colour for the dye
is produced—from *Weld*, the *reſe*
ſiderably common in Europe,—fr
the *Morus Tinctoria* a large tree
from *Annotta* a ſubſtance prepared
ſeeds of the *Bixa Orellana*,—from
tula tinctoria,—from *turmeric*, the
from ſome other plants. Metallic
ſalts are to be uſed as *mordants*
of the Colouring-matters upon the
are conſiderably various and con

FAWN-colours are produced by means of *walnut-peels*, *ſumach*,—*rhus coriaria*; a plant, the growth of Syria, ſtine, Spain, and Portugal,—from the bark of the rch, or *betula alba*, &c. 14. Fawn Colours.

GREEN; the mixture of blue with *yellow*, is permantly produced on Cloths, by inducing either a blue upon yellow, or a yellow upon a brown. The proportions two primary colours may be varied—according as a per or a lighter ſhade of the green is deſired. here is alſo a *Saxon Green*, which is produced from the tion of Indigo in ſulphuric acid. *Mordants* or *baſes* requiſite in dyeing *Greens*; and a variation in the *rdants* occaſions a correſponding variation in the co produced. 15. Green.

The *mixtures* of *red* and *blue* give the violet, purple, —amaranth, lilac, &c. colours. Acetic ſalts are ,—as *baſes*. The mixtures of *red* and *yellow* af alſo many beautiful diverſities of colours. *Browns greys* reſult from the mixture of black with other urs. 16. Mixtures of Red and Blue.

Of *Dyeing* in general, then, this is the Chemical The oit: *Light* is ſimply the medium through which par qualities of the exterior ſurfaces of all bodies, are veyed to the human mind by the eye. All bodies ch have viſible colour, poſſeſs that colour in the mi chemical and mechanical arrangement of their ex parts. Many mechanical changes, but in particu every chemical change, in bodies, effect alterations ir colours. Theſe alterations are,—DEMONSTRA ly,—produced,—not by the varying fixation of erent parts of the matter of Light,—but ſimply, by nical and chemical changes in the moſt intimate and minute 17. Chemical Theory of Dyeing.

[illegible]
[illegible]
[illegible]
water,
[illegible]
[illegible]
[illegible]
[illegible]
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curi
fected
ties, t
produce
proved,
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chemica
bodies ;
The
these ma
ization
its natur
in a man

t down to the fineſt ſtate of pulverization, and, in e, are intermingled with a fluid matter which gives parts of the powder, a tendency to adheſive union another. Oils, alcohol, water, attenuated are the only ſubſtances capable of performing this mixture with Painter's colouring matters. Theſe nicate their ſoft adheſiveneſs of nature to the co- etain them in that ſoftneſs while they are to be ; then hardening, with them, produce the proper of the colour upon the canvas.—The painting *licoes*, &c. is in its nature, ſomewhat intermediate painting upon canvas and dyeing.

ral, vegetable, and animal ſubſtances are all uſe- dyeing and painting. Only, it is neceſſary, that matters as are thus employed, ſhall, be, in the degree, fixed in their nature, or ſuſceptible of the deſtructible fixation.

Manufacture of Sugar.

AR is a ſubſtance which exiſts either ready-formed, ſt in its elements, in very many vegetables. It where, the baſis of that which is called—*Sweet-* Its preſence is previouſly neceſſary in order to the place of vinous fermentation. Its *extraction* from which afford it in the greateſt abundance, and its for the common uſes of life, in a pure and ſe- 1. Origin of Sugar.

parate ſtate, are among the moſt important of the Chemical Manufactures. The Sugar Cane, the *Saccharum Officinarum*, however, yields Sugar, in a proportion ſo much larger than that in which the ſame matter is to be obtained from any other, that only this Cane has been as yet cultivated, expreſsly for the purpoſe of affording Sugar to the extraction of the manufacturer.

2. Ancient Culture of the Sugar-Cane.

This Cane has been from the moſt ancient times known in Aſia. Of its produce, ſome ſmall proportion appears to have been, during the greatneſs of ancient Rome, imported by circuitous channels, into Europe. In the progreſs of the ſubſequent ages, the plant itſelf became known in Europe, and was introduced into cultivation. Before the æra of the diſcovery of America, it was in no uncommon cultivation in Spain. The Spaniards carried out plants of the *Sugar-Cane* to America; but the plant had been, even before, propagated in this hemiſphere. They had not been long ſettled in their new colonial ſeats, till they made Sugar a principal article in their manufacture and agriculture. It has continued, ever ſince, to be the principal produce of the European, colonial territories, in the Weſt India Iſles. It is produced, alſo, in very large quantities in the Eaſt. The Anglo-Americans extract it from the maple-tree. The Cane is a produce of all the South-Sea Iſles of late diſcovery. In Pruſſia, and other parts of Germany, it has begun to be extracted from a particular ſort of beet. The following is the mode of its manufacture in the Weſt Indies.

3. Weſt-India Culture of the Sugar-Cane, and Manufacture of Sugar.

The plants are cultivated in rows, on fields enriched by ſuch manures as can be the moſt eaſily procured, and tilled with the plough. They are annually cut. The cuttings are carried to the mill. They are cut into ſhort pieces,

pieces, and arranged in ſmall bundles. The mill is wrought by water, wind, or cattle. The parts which act upon the canes, are upright cylinders. Between theſe, the Canes are inſerted, compreſſed, ſqueezed till all their juice is obtained from them, and are, themſelves, ſometimes, even reduced to powder. One of theſe mills of the beſt conſtruction, bruiſes canes to ſuch a quantity, as to afford, in one day, 10,000 gallons of juice—when wrought with only ten mules. The expreſſed juice is received into a leaden bed. It is thence conveyed into a veſſel called—the *Receiver*.

4.
First, impure juice of the Cane.

This juice is found to conſiſt of eight parts of pure *water*, *one* part of *ſugar*, *one* part of *oil* and gummy *mucilage*. From the greener parts of the Canes, there is apt to be, at times, derived, an acid juice which tends to bring the whole, unſeaſonably, into a ſtate of acid fermentation. Fragments of the ligneous part of the cane, ſome portions of mud or dirt which unavoidably remain on the canes, and a blackiſh ſubſtance called the *cruſt* which coated the canes at the joints, are, alſo, apt to enter into contaminating mixture with the juice.

5.
The juice conveyed to the Boiling-Houſe.

From the receiver, the juice is conducted along a wooden gutter, lined with lead, to the boiling-houſe. In the boiling houſe, it is received into copper-pans or cauldrons which have the name of *Clarifiers*. Of theſe *Clarifiers*, the number, and the capacity muſt be in proportion to the quantity of the *canes*, and the extent of the ſugar-plantation, on which the work is carried on. Each *clarifier* has a ſyphon or cock, by which the liquor is to be drawn off. Each hangs over a ſeparate fire; and this fire muſt be ſo confined, that by the drawing of an ironſlider fitted to the chimney, the fire may be, at any time, put out.

6. Proceſs of Clarification.

In the progreſs of the operations, the ſtream of juice from the receiver, fills the *clarifier* with freſh liquor. Lime in powder, is added in order to take up the oxalic acid, and the carbonaceous matters which are mingled in the juice. The Lime alſo, in the new ſalts into the compoſition of which it now enters, adds itſelf to the ſugar, as a part of that which is to be obtained from the proceſs. The Lime is to be put in, in the proportion of ſomewhat leſs than a pint of lime to every hundred gallons of liquor. When it is in too great quantity, however, it is apt to deſtroy a part of the pure saccharine matter. Some perſons employ *alkaline* aſhes, as preferable to *Lime* for the purpoſe of abſtracting the extraneous matter. But, it is highly probable, that Lime judiciouſly uſed, might anſwer better, than any other ſubſtance whatſoever.

7. Continuation of that proceſs

The liquor is now to be heated almoſt to ebullition. The heat diſſolves the mechanical union, and thus favours the chemical changes, in its different parts. When the proper heat appears—from a riſing ſcum on the ſurface of the liquor, to have been produced,—the fire is then extinguiſhed by the application of the damper. In this ſtate of the liquor,—the greater part of the impurities,—being different in ſpecific gravity, from the pure ſaccharine ſolution,—and being alſo of ſuch a nature as to yield more readily to the chemical action of heat,—are brought up to the ſurface, in a ſcum. After this ſcum has been ſufficiently formed on the cooling liquor,—this liquor is carefully drawn off, either by a ſyphon which raiſes a pure ſtream through the ſcum, or by a cock dra at the bottom from under the ſcum. The ſcum, in either caſe, ſinks down, unbroken, as the liquor flows; and is, now, by cooling, of ſuch tenacity, as not to tend to any intermixture with the liquor.

8. Evaporation of the ſaccharine Solution.

The liquor drawn, after this purification, from the boiler, is received into a gutter or channel, by which it is conveyed to the *grand copper* or *evaporating boiler*. If made from good canes, and properly clarified; it will now appear almoſt tranſparent. In this copper, the liquor is heated to actual ebullition. The ſcum raiſed to the ſurface by the boiling, is ſkimmed off as it riſes. The ebullition is continued till there be a conſiderable diminution in the quantity of the liquor. The liquor now appears nearly of the colour of Madeira wine. It is at laſt transferred into a ſecond and ſmaller *copper*. An addition of lime-water is here made, both to dilute the thickening liquor, to detach ſuperabundant acid, and to favour the formation of the ſugar. If the liquor be now in its proper ſtate, the ſcum riſes in large bubbles, with very little diſcoloration. The ſkimming and the evaporation together, produce a conſiderable diminution in the quantity of the liquor. It is, then, transferred into another ſmaller boiler.

In this laſt boiler, the evaporation is renewed, and continued till the liquor is brought to that degree of thickneſs at which it appears fit to be finally cooled.

9. Renewed evaporation —and granulation of the Sugar.

In the cooler,—a ſhallow wooden veſſel of conſiderable length and wideneſs,—commonly of ſuch a ſize as to contain a hogſhead of ſugar,—the ſugar, as it cools, granulates, or runs into an imperfect cryſtallization, by which it is ſeparated from the melaſſes,—a mixed ſaccharine matter too impure to be capable even of this imperfect cryſtallization. To determine,—whether the liquor be fit to be taken from the laſt boiler to be finally cooled,—it is neceſſary to take out a portion from the boiler, and try, ſeparately, whether it does not ſeparate into granulated ſugar and melaſſes.

10.
Separation of the Sugar from the Melaſſes.

From the cooler, the ſugar is removed to the curing-houſe. This is a ſpacious, airy building. It is provided with a capacious ciſtern for the reception of melaſſes, and, over the ciſtern, is erected a frame of ſtrong joiſt-work, unfilled and uncovered. Empty hogſheads, open at the head, bored in the bottom with a few holes, and having a ſtalk of a plantain leaf thruſt through each of the holes, while it riſes at the ſame time, through the inſide of the hogſhead,—are diſpoſed upon the frames. The maſs of ſaccharine matter from the coolers is put into theſe hogſheads. The melaſſes drip into the ciſtern through the ſpongy plantane-ſtalks in the holes. Within the ſpace of three weeks, the melaſſes are ſufficiently drained off; and the ſugar remains dry. By this proceſs, it is, at laſt, brought into the ſtate of what is called *muſcovado* or *raw ſugar*. This is the general proceſs in the Britiſh Weſt Indies. In this ſtate, our Weſt India ſugar is imported into Britain. The formation of *Loaves of White Sugar*, is a ſubſequent proceſs.

11.
Clayed Sugars.

In the French Weſt India Iſles, it has long been cuſtomary—to perform the laſt part of this train of proceſſes, in a manner ſomewhat different, and which affords the ſugar in a ſtate of greater purity. This preparation, taking the ſugar from the *cooler*, then puts it, not into hogſheads with holes in the bottom, as above,—but into *conical pots*, each of which has, at its bottom, a hole half an inch in diameter, that is, in the comm

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eſs, ſtopped with a plug. After remaining, ſome
in the pot, the ſugar becomes perfectly cool and
l. The plug is, then, removed out of the hole; the
is placed over a large jar; and the melaſſes are ſuf-
l to drip away from it. After as much of the me-
s as will eaſily run off, has been, thus, drained away;
ſurface of the ſugar in the jar, is covered with a
um of fine clay; and water is poured upon the clay.
water oozing gently through the pores of the clay,
ades the whole maſs of the ſugar, rediſſolves the me-
s ſtill remaining in it, with ſome part of the ſugar
ſ, and carrying theſe off by the hole in the bottom of
pot, renders that which reſiſts this ſolution much
r than the *Muſcovado* ſugar, made in the Engliſh
. The ſugar prepared in this manner, is called
ed Sugar. It is ſold for a higher price, in the Eu-
an markets, than the *Muſcovado* ſugar. But, there
loſs of ſugar in the proceſs by *Claying*, which deters
Britiſh planters from adopting this practice ſo gene-
r as do the French.

12. Baking of White Sugar.

he *raw* ſugars are ſtill contaminated and debaſed by
xture of acid, carbonaceous matter, oil, and colour-
reſin. To free them from theſe, is the buſineſs of
European *Sugar-bakers*. A new ſolution; clarifica-
with alkaline ſubſtances fitted to attract away the
acid, and other contaminating matters; ſlow evapo-
n; and a final cooling in ſuitable moulds; are the
eſſes which, at laſt, produce loaves of *white ſugar*.

13. Farther Purification of the Melaſſes

he *melaſſes* being nothing elſe but a very impure re-
of the ſugar from which they drip, are ſuſceptible of
g employed in a new ebullition by which a ſecond
ity of ſugar may be obtained from them.

14. Rum. The remainder of the *melaſſes* is employed to yield *Rum* by diſtillation. In *Rum*, alcohol is mixed with oil, water, oxalic acid, and a mixture of empyreumatic matter.

15. Wine from Melaſſes. The French prepare from the mixture of *melaſſes* with water, a ſpecies of wine, of good quality. In its preparation, the ſolution is brought into fermentation,—then paſſed through ſtrainers to purify it,—then put in caſks,—after clearing itſelf in theſe,—transferred into others, in which it is to be preſerved for future uſe.

16. Ratio of Manufacture of Sugar. The ratio of theſe proceſſes, is extremely beautiful. They are all directed—to purify the ſugar from contaminating mixtures,—and to reduce it into that ſtate of dryneſs or cryſtalization, in which it is ſuſceptible of being the moſt conveniently preſerved for agreeable uſe. The *heat* in general acts both *mechanically*—to effect a ſufficient diſſolution of the aggregation of the parts of the cane-juice,—and *chemically*—to produce in it, new combinations into which Caloric muſt enter, as an ingredient. The *firſt* gentle heat, is intended, chiefly to operate with a mechanical influence,—raiſing to the ſurface, impurities which are more conveniently removeable by ſkimming, than by any other means. A gentle, not a violent heat, is, in this inſtance, employed; becauſe a violent heat would produce empyreumatic ſalts, the production of which, is to be carefully avoided. A *boiling heat*, is in the continuation of the proceſſes, made uſe of,—becauſe, after the firſt impurities have been ſkimmed off, contaminating empyreumatic ſalts are leſs readily formed,—becauſe a boiling heat is neceſſary to effect a complete developement of all the parts of the ſaccharine matter,—and becauſe the gradual concentration of the ſugar is, by ſuch a heat, to be beſt accompliſhed.

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it has a ſtronger affinity than *Sugar*, with all the
nating matters,—and particularly, *becauſe* it at-
nto a neutral combination, that exceſs of oxalic
hich is apt to exiſt in the ſaccharine ſolution.
ng removes the new ſalts which the moſt eaſily
a ſolid form. The *dripping* carries away a mix-
water, oil, earth, ſugar, from the cryſtallized ſugar:
all our cryſtallizations, we can never perform the
in the great way, with ſuch nicety as to preſerve
from an inequality of proportions, that muſt ne-
occaſion a reſiduum. Repeated ſolution, clarifi-
evaporation are requiſite to produce pure white
om the *brown* and *raw* ſugars: becauſe the com-
rification of this matter from acid and colouring
is an operation of great difficulty, and not to be
completed without proceſſes longer than can be
iently performed, at the firſt, upon the Sugar
on.

172
Extraction of Sugar from European Vegetables.

n vegetables of European growth, Sugar is not to
y obtained, unleſs the proceſs of germination be
duced in them,—or unleſs they have been pene-
y intenſe froſt. Germination or thorough freez-
elope ſugar in all vegetables in which its principles
drogen and Carbon, with a ſmall proportion of
n, exiſt in any conſiderable plenty. It is not im-
le but that, if penetration by a freezing cold might
manded at pleaſure, with ſufficient cheapneſs,—it
enable us to obtain ſaccharine matter, in a
proportion, from a variety of ſubſtances from which
rmination does not yield it in ſufficient quantity.
Sugar beet and ſome other European vegetables,
is naturally formed by the functions of vegetation,
to

A few days before it is to be actually infuſed in tha
is called the *maſh-tub*, let it be ground in the mi
ground at this diſtance of time before the BREWIN
4. Preſervation and grinding of Malt. then preſerved dry ; it will more eaſily give out
ſaccharine matter, in the infuſion in which it
be uſed.

5. Formation of the Wort. It is, in the commencement of the BREWING,
put into the *maſh-t* a veſſel in which the ſac
matter is to be extracted from the malt by m
Boiling Water, poured upon it, left ſome time in
with it, at laſt conducted away with the ſacchar
fermentible matter which it has taken up. Th
ſhould be running water, boiled, as well to free
impurities, as to bring it into that temperature i
it is fitteſt to accompliſh the purpoſes of the i
The water is, firſt, to be put into the *maſh-tub*,
firſt, violent evaporation has ceaſed ; it is, then,
put in the malt. The *maſh* ſhould ſtand, from on
hours, before the liquor of the infuſion be drawn
taſh-vaſe, or rather a falſe bottom with holes, is
the *maſh-tub*, to free the liquor from the groſſ
rities, as it advances toward the *Cock* by which
be drawn off.

6. Boiling of the Wort. The Liquor now receives the name of *Wort*.
to carry off a part of the water, to perfect the c
of the ſaccharine matter, to mix the ingredients i
lution more thoroughly together, and to drive
part of the impurities from the infuſion,—it is to
while, carefully boiled in a proper veſſel. Th
ſhould be performed with a briſk, vigorous
needs not to be continued for more than the
an hour.

7. Cooling of the Wort.

m ebullition in the Copper, the *Wort* is to be con-
into veſſels in which it may cool. In *Brew-houſes*,
ſhould be two large *coolers*, appropriated to this ex-
uſe. Theſe ſhould be ſuch, that as large a ſurface as
le of the WORT, may be expoſed, at once, to the
ir. It is of conſequence, that the cooling be rather
han ſlow.

m the *coolers*, the WORT is transferred to the
g-*tub*. If the *Wort* be perfectly cool, it may be poured
e *working-tub*, in a pretty ſtrong ſtream. If otherwiſe,
ribble ſlowly from the cooler to the working-tub.—

8. Excitement of the vinous fermentation.

EAST is to be added, in order to excite the *vinous*
tation, as ſoon as the WORT has been transferred
he working-tub. Add it gradually, and in ſmall
s, in order that the vinous fermentation may be, at
ntly excited, and may gradually riſe to work with
energy. It is good to ſtir the Liquor in the
g-tub, when each new addition of yeaſt is made.
orking is to be continued, till the vinous fermentation
ppear to have thoroughly pervaded the whole maſs
uor,—but not till the *Yeaſty matter* ſhall fall to the
.

9. Addition of Hops.

s are added to the *Ale* or *Beer*,—becauſe they afford
ous, aromatic matter, which is requiſite to correct
ty and ſweetneſs, and to render the liquor capable of
ation for a due length of time. The beſt *hops* are
e green colour, have a ſtrong ſcent, ſtick to the
when rubbed, and have the ſeeds full and yellow.
al to add ½ lb. of hops to the *Ale*, for every buſhel
It is, in Britain, prohibited by Law, to uſe any
ſubſtance, in brewing, as a ſubſtitute for hops.—
llons of good Ale, may be brewed from one buſhel
lt. As hops ſerve to prevent the coming on of

the Acetous Fermentation; it is thought a good
to add a ſmall portion of new hops to beer in the
juſt when the barrel is about to be tapped.

10. Barrelling of Ale.

After the proceſs of fermentation has been co
after the hops have been added for the embitteri
preſervation of the Liquor; that liquor is, then
drawn off, into barrels. Theſe ought to be exc
clean, well-ſeaſoned, and in ſuch a ſtate, that th
communicate no contaminating matter, to alter
or *ale*. The *cellar*, in which they are to be de
ſhould be clean and gelid. The barrels ſhoul
cloſe as not readily to ſuffer the eſcape of either
or carbonic acid. If there be a ſtrength of alco
of reſinous, aromatic, and perhaps bituminated
ſufficient to reſiſt the tendency to acetous ferment
if the liquor be pure from that mixture which mig
produce a tendency to putrefactive fermentation,
acceſs of airs from without, and all eſcape of gaſ
within, can be prevented,—and if it be kept in a te
ture which has no power to develope new gaſes
the barrels;—then, may this Liquor be preſerved
indefinite length of time: and the longer it is pr
ſo much the better it will ſtill become; becauſe, ſ
the more perfect muſt the combination of its princi
be rendered.

11. Differences of Ales, &c.

Porters, Ales, Beers of different qualities and
characters, are, all, produced by differences of the
dients, of the water, of the malting, of the mana
of the infuſion, of the conduct of the fermentat
the addition of hops, of the depoſiting in the bar
the preſervation in the cellars, of the managemen
tapping, &c.

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12. Ratio of Malting and Brewing.

Ratio of *Malting* and *Brewing*, deſerves particular In *Malting*, we produce by means of germina- change in the union of the principles of the grain, ich the ſaccharine combination is formed in it. the malt on the kiln, we not only drive off a por- water, but alſo procure, in conſequence, a ſort of ement of carbonic matter. The *water* to be uſed infuſion, muſt be pure,—otherwiſe its ſalts would rt the infuſion, and otherwiſe injure the taſte of . *Infuſion* is employed to extract the ſaccharine with whatever other ſolution or mucilage is to be d from the malt. We uſe *hot* not *cold* water—be- eat is neceſſary both to the mechanical deſtruc- the aggregation, and to the chemical changes which e wanted. The Liquor from the infuſion, is to be that the mixture and combinations of its minute s, may be more complete, and more uniformly the every part. *Yeaſt* is employed to favour the com- ent of the vinous fermentation, juſt in the ſame as burning coals are neceſſarily uſed to kindle a h combuſtible ſubſtances,—and juſt as contagious nduces diſeaſe in the human body. It contains a ation of matter in a ſtate of fermentation. The *fermentation* produces a *new compoſition* of *alcohol* lid not, before, exiſt here, otherwiſe than in its s, and an evolution of *carbonic* acid from the de- tion of the ſaccharine matter of WORT. The is produced by the reciprocal decompoſition of the and Sugar of the WORT; in which proceſs, rt of the oxygen of the water joins with the diſengaged from the Sugar, and in the form of carbonic

as the fluid m
proportionate
Ale, beer, or
which it is f
tion or other
reumatic matt
pregnation of
and aſtringent
are added to tal
undecompoſed,
means of their
haſty decompoſ
ſaccharine matt
ſmall. The de
mentation, prod
alcohol. It has,
vapid by giving
or from a deficie
ceed, too haſtily,
tion. It is better,
the barrel before
poſed by the vi
alcohol and carbo

ny for the preſervation of your *Ale* or *Beer*,—be-
as is well known, any conſiderable heat would tend
duce the *Acid* fermentation, even in Liquor of con-
le ſtrength. Cloſe veſſels, and great care in tranſ-
it from one to another, are neceſſary; becauſe its
e parts have a continual tendency to eſcape into the
ving only the water with other remains of a fixed
—Preſervation for as long as you can keep the vo-
ts from eſcaping, is generally improving to malt
; becauſe it is only thus, that the moſt perfect in-
of mixture and combination in all their minuter
ary parts, can, with certainty, take place.

13
Wines.

preparation of Wines from grapes, is a proceſs not
ingly different from that of brewing ale and beer
alt. The grapes ſhould be taken in that ſtate in
the developement of their Sugar is the moſt com-
They ſhould be freed, as much as poſſible, from
of aqueous and acid matter. Preſſure gives the
rine liquor with which they are filled. It often
s alſo, a mixture of alkali, of iron, of acids. Fer-
ion developes its alcohol. The iron, alkaline,
matic, and reſinous matters, which it naturally con-
ake away the neceſſity for the uſe of hops. Long
ation in ſufficient cold, and ſo as not to permit the
of its volatile parts, brings it to full perfection.
iderable proportion of ſaccharine matter remains,
wines, undecompoſed, to the laſt. The common
are compounds of water, ſugar, alcohol, acid, re-
ma, and more or leſs of alkali.

14
Wines from
common
fruits.

berries, *currants*, *oranges*, &c. are capable of af-
wines, by due preparation. The preparation con-
forming from them, a ſaccharine ſolution, ſubject-

Book IX. Sect. IV. ing that ſolution to vinous fermentation, and, after
mentation, preſerving the liquor to due maturity.
fruits have generally exceſs of acid, and are defic
reſin and ſugar. Sugar is largely added in the p
tion of the *wines*. The deficiency of reſin and
cannot be, ſo eaſily, well ſupplied.

14. Cyder, perry, &c. *Apples*, *pears*, *honey* afford, alſo, liquors participa
the qualities of ale and wine. Theſe liquors are a
duced, like the former, by the preparation of a ſacc
fluid mixture, the bringing of it into vinous fermen
the ſtopping in due time, of the progreſs of that ferm
tion, and the preſervation of the liquor till its parts are
intermingled, and its ſolidifiable impurities are dep
The liquors prepared from theſe different ſubſtances,
in taſte and flavour, according to the variation in
proportions of alcohol, reſin, acid, &c. All ſubſ
capable of affording ſaccharine matter, and of preſ
materials, to undergo vinous fermentation, are, by
quence, capable to afford liquors of the nature of b
wine.

15. Diſtillation of ſpirits. It is often deſired to obtain ALCOHOL more in a
rate ſtate, than as it preſents itſelf in beer or wine.
is accompliſhed by a proceſs of DISTILLATION fro
quor which has undergone the vinous fermentation.
diſtillation gives, in the receiver, the *alcohol*, as one
moſt volatile parts of the vinous liquor. With the
hol, however, there are mixed other matters from the
mented liquor under diſtillation, or originating from
empyreumatic formation, during the proceſs. *Win*
ford *brandies*; The fermented ſolution of *melaſſes*, af
rum: The fermented liquor from *malt*, yields what is
whiſkey. The alcohol obtained by diſtil

rent liquors, is always far from being in ſufficient pu-
. So many different ſubſtances are ſoluble in alco-
that this cannot eaſily be otherwiſe. There is al-
s, in the firſt diſtillations, more or leſs of water inter-
gled with it : It contains often carbonated hydroge-
s gas, empyreumatic acids, ſuch as the pyro-mucous
the pyro-tartareous, oil, carbon, &c. : And it is apt
e contaminated, even with various other matters. In
r to obtain alcohol as pure as poſſible, it is proper to
ll it from ſuch fermented liquors, as contain the
ſt other matters beſide the alcohol and water,—as
as to manage the diſtillation in ſuch a manner, that
nall a proportion as poſſible, of new empyreumatic
, may be formed while it proceeds. All the alcohol
ch is in common uſe as a ſpiritous liquor, is vari-
y contaminated. The uſe of that which contains
h of empyreumatic acid, of carbonated, or of bitumi-
d gas, is apt to prove exceedingly noxious. After
g a proper fermented liquor,—and diſtilling it cau-
lly,—the next thing requiſite, in order to have good
s or alcohol,—is, to preſerve that ſpirit long in a
, in which the alcohol may not evaporate,—and the
aminations may be depoſited. Nothing can have a
ter tendency to produce noxious ſpirits, than too
diſtillation, by too great violence of fire, from mat-
in which the alcohol is but imperfectly formed.

IX.

The Tanning of Leather.

1. Object of the Art of Tanning.

The *Tanning of Leather* is an eminently curious and uſeful Art. Its object is,—to communicate to certain *animal ſubſtances, an artificial durability, that ſhall reſiſt, even under extraordinary violence and expoſure, and without a mechanical deſtruction of the organic texture, their natural tendency to be chemically decompoſed as ſoon as the preſerving power of Vitality, has ceaſed.* It is an art of infinite utility. It provides us with ſhoes, boots, breeches, ſaddles, coaches, harneſſes, and with a great multiplicity of other articles of the moſt uſeful convenience, and the moſt elegant decoration.

2. Natural tendencies reſiſted by tanning.

The ſkins of animals,—whether fowls, fiſhes, or creatures living on the dry ſurface of the earth,—combine pliability with durability, in a very conſiderable degree. But, when animal life has ceaſed to continue the changes which went on in them; they tend to a putrefactive fermentation; in which their azote and other naturally gazifiable principles being evolved; they muſt, of courſe, undergo a complete chemical diſſolution. In order to fit them for the beſt human uſes; their tendency to putrefaction is to be ſtopped in its firſt progreſs. This is what the *Art of Tanning* performs.

3. Preparation of hides for Tanning.

In this Art, it is the firſt object, to free the ſkins from the hair and from the reſt of that exterior matter on both ſides, which, either could not be eaſily preſer
reſt,—would hinder the proper dreſſing of

e uſeleſs, if it could even be conveniently dreſſed ſerved. This is effected by ſuffering the com- ent of putrid fermentation, to approach, in the ſcraping off the hair and other outward parts of he conſiſtency begins to be deſtroyed,—and work- the ſides of the hide with the edge of a knife, ſo as its texture to the full influence of the proceſſes re to ſucceed. Book IX. Sect. IV.

4. Uſe of Alum in Tanning. ſe of an *aluminous ſolution* ſolely,—*ſulphate of alu-* is ſufficient to give to hides which it has tho- penetrated, a toughneſs, pliability, and durability what they naturally poſſeſs. *Leather* prepared ſim- th *alum*, is ſufficiently fit for many uſes in which ot to be particularly expoſed to moiſture. Even , alone, ſufficient to preſerve hides from the pu- ve fermentation, but not to give the pliability and ity which are neceſſary to fit them for convenient t is the nature of aluminous earth, and of the ſalts ich it enters, to be diſſolved by water,—though al- the earth itſelf be, on the other hand, liable, even to raordinary degree, to be hardened and diminiſhed ulk, and made more obſtinately tenacious, by the of fire.

5. Uſe of Lime. , on account of its tendency to promote, in cer- rcumſtances, the putrefactive diſſolution of animal , is fit to be employed for the purpoſe of haſten- incipient deſtruction of thoſe parts at the ſurfaces *hide*, which are removed, in order that the reſt of be prepared for preſervation and uſe.

Nature of the cleaned hide. r all is removed, but the proper, coriaceous texture *hide*,—the hide itſelf is a compound of carbon, hy- n, and azote, with perhaps ſome little oxygen; and it exhibits theſe ingredients united in peculiar proportions, and wrought by the organic functions of Animal Life, into a particular, uniform, preſervable texture.

7. Matters of the ſame element, neceſſary to preſerve hides.

The only effectual means for the preſervation of this texture, as well when it is attacked by moderate heat, as under the action of water.— conſiſt, in penetrating its ſubſtance without deſtroyi[illegible] texture, with matters compounded of the ſame elements, as itſelf, but much leſs eaſily deſtructible. *Alum* and other ſaline matters of elements different from its own, are inſufficient to accompliſh this end, of the[illegible]elves,—though they may be made to contribute to it.

8. Aſtringent acids uſed in Tanning.

The ſubſtances which poſſeſs, in the moſt eminent degree, the power of preſerving hides under every diverſity of uſe, without diminution of their natural texture and flexibility, are, more eſpecially, the Acids with baſes of hydrogen and carbon, ſuch as the Gallic Acid, the Cortic Acid, the Lignic Acid, and even the empyreumatic Acids. The oxygenous part in the compoſition of theſe acids tends to make them of a penetrating aſtringent nature: But, as that oxygen is, already, ſaturated with hydrogen and carbon in the acids; it cannot accompliſh any decompoſition of the new hydro carbonous matters with which it is brought into contact. Even the hydrocarbonous part of the acids operates with a ſort of aſtringent power. The whole acid compoſition tends remarkably to penetrate the ſubſtance of *hides* to which it may be applied. It is, in the inſtance of the *Gallic* and the *cortic* acids, eaſily to be extracted by means of infuſion in water: And hence, it can be, without great difficulty, applied to *hides*.

9. Immediate manipulations of Tanning.

Accordingly,—*barks, eſpecially that of oak*,—are employed, in mixture with water, &c. in forming what the tanners call an *ooze* in which, *hides* previouſly cleared from every excrementitious ſubſtance, and opened, as much as poſſible, by previous ſoaking in water, to the admiſſion of tanning matter,—are to be immerſed, for the purpoſe of thoroughly imbibing, in all their parts,—the cortic and gallic acids which are diffuſed from the barks. The ſtrength of the *ooze* in acid, the proper management of the matters and the temperature which are to aſſiſt its operation, the ſtate of the hide at the time when it is ſubmitted to the action of the *ooze*, the length of time, during which it remains under this action, are the circumſtances upon which perfect excellence of tanning, chiefly depends. It is a matter of uncommon nicety, to make the *ooze* juſt of its proper ſtrength. It is of great conſequence, to preſerve the proper temperature. The moſt important thing of all, is, to procure the complete penetration of the hide to its moſt intimate particles, by the particles of the tanning liquid. There is a certain nice proportion in which this is to be effected with the moſt uſeful conſequences. But, in that happy proportion, the object is ſcarcely ever attained. *Tanning* is, in this reſpect, almoſt always, either *over-done* or *under-done*. Moſt commonly it is *under-done*. When *over-done*, the hide is apt to be converted into a dry, hard, bituminated matter. Moſt commonly, the tanning is irregularly and unequally performed: The hides are not, in all parts thoroughly penetrated. One part is *over-done*,—another, *under-done*. Improvements in TANNING are frequently propoſed and tried, by which the proceſs is to be performed *more quickly*, than in the ordinary way. Few of theſe ever in any tolerable degree ſucceed. Few of them ever can ſucceed. Tanning is a proceſs in which we imitate thoſe ſlow chemical operations of Nature which produce the juices and ſolids of vegetable and animal bodies. The addition of the tanning matter,—as it were,—*particle by particle*,—to the matter of the hide, cannot poſſibly be accompliſhed,—*without a deſtruction of the texture of the hide*,—otherwiſe than by the very long continued immerſion of the hide in the tanning liquid. This proceſs may be cheapened and improved; but it is ſo cheapened and improved—only—by the adopting of the uſe of new ſubſtances which can afford the tanning acids,—by the uſe of intermedia which ſhall more effectually fix thoſe acids in the hides,—by the better preparation of the *ooze*,—by the better management of temperature,—by the better ſecuring of the tanning matters from being diſturbed and waſted in the proceſs,—by the better dreſſing of the leather, after it comes from the tan-pit,—ſcarcely, if at all, by any quicker proceſs of penetrating the hide with the tanning matter, without a deſtruction of the texture of the hide.

10. Uſe of Oils in the manufacture of Leather.

But, as the action of the *tanning acids*, and the liquid in which they are applied, might operate with too powerful a conſtringency, on the hides which they are to convert into *Leather*; it becomes neceſſary to employ, alſo, other ſubſtances, ſuch as animal oils, in order both to confirm the preſerving power of the aſtringent acids, to improve the ſoftneſs and flexibility of the *Leather*, and, in ſome meaſure, to thicken and encreaſe its ſubſtance.

The whole proceſſes, mechanical and chemical, of preparing Leather from hides, are performed by the tanner, and the *currier*. In that lighter dreſ furniſhes the materials for gloves; they are rather than tanners who are employed, according to the ces of denomination prevalent in different parts of untry. The lighter ſkins, ſuch as thoſe of goats, ep, of kids, of lambs, are uſed for gloves. The of ſwine are dreſſed for ſaddles. The ſkins of , of dogs, of ſeals, of horſes, of oxen, are uſed for and ſhoes. The leather of the hides of oxen, is that is the moſt commonly applied, whenever there is ant for extraordinary durability and ſtrength.

11. Different hides uſed for different purpoſes.

minute detail of the practices of the *Art of Tanning*, be here given. Its ends are,—to reſiſt the putre- proceſs in the animal ſubſtance of the *Hide*,—to its ſtructure at once more flexible, and leſs eaſily ible by mechanical means.—It performs this by ition of acids with hydro-carbonous baſes, and of mpounds of hydrogen and carbon. Theſe form he ſubſtance of the hides, new chemical com- ſuch as are not to be readily decompounded by ary action of air, heat, and moiſture, to which r is expoſed, in the wearing.

12. Ratio of Tanning.

ER is ſuſceptible of being coloured, at leaſt ſu- lly, by the ſame colouring-ſubſtances which are dye cloths.

13. Colouring of Leather.

Culinary

X.

[illegible] y Arts.

1. Culinary Arts, chemical.

THE preparati [illegible] or human uſe in the kitchen, is almoſt entirely chemi [illegible] Infuſing, roaſting, boiling, baking, dilutions, thickenings, mixtures, with the preparation of ſauces and mixtures, are, all, intended to produce, in our food, new convenience and ſalutarineſs of digeſtion for the ſtomach, new diverſities of agreeable taſtes to the palate, an agreeable change of appearance to the eye, which are to be effected—ſolely by chemical means.

2. Cookery is improveable by Chemiſtry.

In all the different operations of cookery, much improvement might be made, if it were poſſible to have cooks, who to the knowledge of their own Art, could add ſome ſhare of chemical ſcience. By this, they would be taught to avoid much waſte which now unneceſſarily takes place in the preparation of the diſhes for every ſumptuous table. Much uſeleſs toil might be likewiſe prevented to them; and a mighty reformation would be gradually produced in the receipts of the books of cookery. In *roaſting* and *boiling*,—how often are the beſt pieces of animal food, at preſent, waſted,—and how often are articles of nouriſhment rendered leſs ſalutary and leſs nutritious than they would otherwiſe be, by thoſe very means which are ſuppoſed neceſſary to fit them for human uſe? In the preparation of ſauces, pickles, and gravies, much improvement might be made by a due applic [illegible] mical ſkill. The articles might be pre heaply, ſo as never to be noxious, and to be always both holeſome and agreeable.

3. Improvement of Baking by Chemiſtry.

In the *baking of bread*, an improvement equally œconoical and ſalutary, may be effected by chemical attention. *zote* is one of the principal elements of the fibrous fleſh nd blood of animals. In vegetables, this principle is anty: And hence, are vegetables, alone, inſufficient for e plentiful and and vigorous nouriſhment of the animal dy. But, among thoſe vegetables that do contain azote, heat is one in which it exiſts in the largeſt proportion. exiſts in the dark coloured gluten of the wheat. That utch,—in order to render our bread as white as poſſible, it is uſual, in London, and other parts of Britain, to aſt away from our flour for bread, in much too large a oportion. Now, a juſt chemical knowledge in thoſe ho prepare and thoſe who are to uſe this bread, would ech us, that, the portion of the wheat, which, on acunt of its darkneſs of colour, we the moſt eagerly reject om our bread,—is,—becauſe it contains the moſt azote, more wholeſomely nutritious, than that part which we efer. Inſtead of *white bread*, owing its whiteneſs in rt to improper mixtures of *alum* and *chalk*, we ſhould, iverſally prefer a browner bread, containing a good rtion of that which is now rejected in *bran*. How uch, in years of ſcarcity, this would contribute to hinder e enhancement of that ſcarcity by waſte,—it is not neſſary, here to relate.

4. Œconomy of fewel.

The *œconomy of fewel* is particularly connected with e exerciſe of the Culinary Arts. In ſuch a country as itain, fuel is an article of the moſt important, primary ceſſity. It is continually wanted in every houſe. It is

not

tion of oxygen into the fuel that is burnt, o
of augmenting or diminiſhing the force of f
the quantities of air to the acceſs of which i
is neceſſary, to enable us to regulate ou
meſtic fires in a manner at once the mo
and the moſt uſeful The ſuggeſtions of the
Count RUMFORD, afford the moſt ſatisfact
the truth of this aſſertion. Partly by ingen
and in part from the obſervation of the
ſtoves and fire places on the Continent, he h
to preſent a plan for a chimney, by which t
in burning, is, in a very extraordinary prop
out, from the chimney, into the apartmen
while the air is made to act with ſo much
in exciting the violence of the fire, that, w
cloſeneſs on all ſides of your room, you ſhal
a very ſmall handful of pit-coal, to mai
blazing fire in the chimney. It is, indeed,
cloſeneſs of an apartment which is requiſite
that ſaving of fewel, with that ſtrong dif
which the ingenious and philanthropic
plan has intended, would, probably, be ver
to the health of the perſons living in it:

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eceſſary to the preſervation of the health of the Animal Economy. Nevertheleſs, the whole is an eminent proof, at the beſt advantages may be derived from the chemi- l regulation of our common applications of fire. Even at indiſpenſible requiſite to the comfortableneſs of any meſtic apartment, the clear conveyance away of the oke, is not to be obtained without a chemical attention to relations between fewel, ſmoke, and the air of the at- ſphere. It is indeed by a knowledge of the laws of vity as affecting the atmoſphere, that the moſt is to be ne towards this end. But, without an attention to chemical differences between hot and cold air, all our rely mechanical pneumatics could be, here, compara- ely, but of little uſe.

5. Preſervation of meats by ſalting.

The *preſervation of Animal and vegetable ſubſtances by* *of ſalts*, for future uſe, is wholly a chemical pro- The principle of it is, to *penetrate* or *inveſt* thoſe ances with bodies the preſence of which ſhall prevent putrefactive fermentation which would otherwiſe na- lly come on in them. *Muriate of Soda* and *Nitrate* are the ſalts, the moſt commonly in uſe for the erving of beef, mutton, and other ſorts of animal The Animal matters, duly ſaturated with the neutral become incapable of attracting from the atmoſphere, om the water which may accompany them, that ga- matter which is required to their putrid decompoſi- The ſaline mixture, too, reſiſts that action of heat ch would otherwiſe effect a—partly mechanical,— chemical diſſolution of the hydrogen, carbon and of the animal ſubſtance. By both theſe actions, the matter is preſerved unaltered, and without any tion of its nature as an aliment. Other ſalts, beſide

ſide thoſe which have been mentioned, are capable of anſwering the ſame purpoſe—as to the preſervation of the animal matters But, there are ſcarcely any other ſalts which would not communicate a diſagreeableneſs of taſte, by which, the ſubſtances preſerved, would be rendered unfit for human uſe. *Alcohol*, reſiſting by itſelf, all decompoſition from the actions ordinary in air and water, is capable of effecting [illegible] for any length of time, the preſervation of animal ſubſtances immerſed in it. Indeed, all ſalts or ſpirits which have not naturally, any decompoſing reaction with animal ſubſtances, and which are not themſelves ſpontaneouſly decompoſed by re-actions whether with acceſs of air, or in cloſe veſſels,—all ſuch ſalts are capable of being uſefully employed for the preſervation of ſubſtances animal and vegetable. *Pickles* are formed by the conſervation of vegetable or animal ſubſtances, otherwiſe eaſily decompoſable, in acids and other ſaline mixtures, not without the frequent addition of reſinous and aromatic matters. Much waſte might be ſpared,—and a much better perfection of curing all ſorts of animal and vegetable food for preſervation, might be obtained,—if thoſe to whom the performance of theſe taſks commonly falls, would duly ſtudy the principles of chemiſtry.

XI.

Preparation of Tobacco and Snuff.

1. Uſes of Tobacco.

TOBACCO, a plant of America and the Weſt-India
s, has, for theſe two centuries, been uſed in every
intry of Europe, as an agreeable ſtimulus to the mouth,
mach, and ſalivary glands, and as a ſpecific remedy for
reat variety of diſeaſes. The Spaniards, the firſt Eu-
ean conquerors of America, learned its uſe from the
lians. It was ſoon repreſented by them in Europe, as
oſt an univerſal remedy for all diſeaſe. The Great
ronized its uſe, and eſtabliſhed a faſhion in its favour.
e oppoſition of ſome phyſicians, and the approbation of
ers, conſpired to give it celebrity. Its juice extracted
the mouth by *chewing*, its volatile effluvia taken into the
mach by *ſmoaking*, its aromatous parts applied to the
ans of ſmelling in *ſnuff*, are ſtill, very generally and
bitually uſed, without producing any very pernicious
ects. A chemical preparation, ſubſequent to the culti-
ion in the fields, is employed to fit tobacco for uſe, in
atever form. It cannot be ſaid that ſuch preparation
t preſent regulated by any excellence of chemical ſkill
the tobacconiſts.

2. Culture of Tobacco.

TOBACCO is cultivated, as an article of vegetable crop,
t only in North and South America, but alſo in both
rica and Aſia, and, though not in Britain, in moſt coun-
s on the Continent of Europe. It ſprings from the
ds. The plants, while ſtill very young and ſlender, are
tranſ-

tranſplanted from the field on which the ſeeds are ſown, or another prepared to receive them. A ſhort time of increaſe after they have been tranſplanted, brings them to the full luxuriance of their growth They are cut, dried, ſtripped from the fibres which interſect the leaf, made up in rolls, bundles, ſegars, &c. and laid aſide for uſe or exportation.

This is, in general, the culture of tobacco, and its firſt preparation. The preparation is chemical, only as it employs drying, to remove the preſence of that moiſture which would occaſion the putrefactive decompoſition of the tobacco leaves. In Europe, the preparation of the tobacco, is carried to a much greater length, and is accompanied with many chemical refinements.

3. Chemical manufacture of tobacco and ſnuff.

But, whether the tobacco be to be uſed in leaf prepared for chewing and ſmoaking, or in ſnuff,—the preparation is in every caſe, reſolvable into a very few principal chemical acts. It is ſteeped in what the tobacconiſts and manufacturers of ſnuff, call their *ſauces*: Theſe are ſo prepared, as to impregnate it with large additions of vinous, reſinous, aromatic and alkaline matters. It is often mixed with lime, alkali, &c. in powder; mixtures which tend to aid the native ſtimulating power of the extract and the aroma of the tobacco. It is frequently coloured by the addition of logwood or other ſubſtances of colouring qualities. It is, after all this, to be preſerved in a ſituation where its volatile parts may not be loſt, till the ſecret and ſlow digeſtion as it were of nature, ſhall have given that mellowneſs of flavour and general nature, which no ſudden artificial proceſs of chemiſtry can confer. In the *ſnuffs of tobacco* which are commonly uſed in Europe, there is ever a large proportion of lime or alkali. But for the lime and alkali, ſuch ſnuffs would not greatly ſti melling. Yet, it is certain, that, in any other form, could not fail to think the uſe of lime and alkalis in a manner, highly dangerous. That tobacco which uſed in chewing, and even that which we contrive to it into the ſtomach in ſmoaking, owe alſo much of s ſtimulative energy to the alkaline ſubſtances inter-igled in them. In the Eaſt, no leſs than in Europe, the ctice is the ſame. Alkalis, tartareous acidulum and quick-e are uſed, while people ſuppoſe themſelves to be uſing acco. In the uſe of the *betel-nut*, and of moſt other nous exciters, all nations are obliged to aid by un-lating ſalts, the periſhing aromas which they pretend t they uſe excluſively. In a pound of ſnuff, how y little is there, of genuine, freſh, aromatous tobacco? The manufacturers of tobacco have learned the practice their art from no rational principles. They have ned it from the example of the native Americans, ong whom the plant was firſt found, from the pre-ption of phyſicians who practiſed and preſcribed upon ions and pretences as weak and abſurd as thoſe of the gar, from modes of proceſs that tobacconiſts in this or that ntry, had taken up, and made ſecrets of, without know-well, why. In conſequence of this, there is a very great ſte in all the more refined and expenſive modes of pre-ing ſnuff and tobacco. In moſt of their cheaper parations, there is very great impoſture. The uſe of acco and ſnuff might perhaps be univerſally relinquiſhed hout any diminution of the real comforts and utilities life. Yet, mankind, as it ſhould ſeem, *muſt* have ſti-lants of this ſort. And tobacco is, perhaps, one of the ſt noxious that they can employ. We ſhould wiſh, n, that, by an honeſt, open manufacture, founded

4. Poſſibility of improving the manufacture of tobacco and Snuff.

upon true chemical principles, the ſnuff and tobacco might be prepared for uſe, with as little loſs as poſſible of the true aroma,—without the uſe of an exceſs of alkaline matter ſuch as muſt deſtroy the tobacco, and render its uſe, in ſome ſort, noxious,—without the application of matters in the *ſauces*, which are neceſſarily diſſipated and loſt, befo[illegible] come into uſe.

XV.

Analyſis of Mineral Waters.

1. Former imperfections of the analyſis of mineral Waters.

The *Analyſis of Mineral Waters* was, formerly, one of the moſt difficult taſks which Chemiſtry was accuſtomed to try. The gazeous principles eſcaped notice. The metallic, terrene, and fixed ſaline parts could not be eaſily ſeparated from one another. No artificial proceſs could imitate the Mineral Waters of Nature, or recompoſe any complex ſpecimen of ſuch waters, after it had been once analyſed.

2. Improvement in Analyſis of Mineral Waters.

Thoſe improvements in Chemiſtry, which have taught us to diſtinguiſh, and to take an account of, *gazeous products*, have made it much more eaſily poſſible, than it was before, to accompliſh the perfect Analyſis of *Mineral Waters*. It is poſſible to preſerve all the products of ſuch an Analyſis without loſs, to ſeparate all the component

parts of any mineral water from one

e, artificially, almoſt any mineralized water that
ts itſelf to us, in Nature.

3. Diverſity and nature of Mineral Waters.

but *rain-waters*, are, *ſtrictly ſpeaking*, more or leſs
alized. Water has ſuch univerſal ſolvent powers,
cannot paſs along the ſurface of the earth, cannot
deſcend under the ſurface, without acquiring an
gnation of thoſe matters, ſolid, liquid, or gazeous,
which it thus comes into contact. Even *running*
r have uſually, more or leſs of ſand and clay alumi-
nd ſiliceous, uſually ſuſpended in them, even when
re in their beſt ſtate of purity. The *ſtanding wa-*
lakes and *marſhes* are contaminated with a thouſand
, animal and vegetable, haſtening into a ſtate of
cency. It rarely happens, that the waters of wells
n the earth, are not impregnated with calcareous
to which are often ſuperadded ſalts ſulphuric and
ſian. But, thoſe which we call *Mineral Waters*—
y of eminence, owe their chief mineralization to—
-to ſulphur,—to ſulphuric ſalts of various ſpecies,
gas-hydrogen ſuſpending in itſelf particles of ſulphur
treme comminution,—and indeed to a very great
ty of the ſolutions of neutral ſalts,—as alſo in very
inſtances, to carbonic acid.

4. General Directions for the analyſis of theſe Waters.

e taſte, the ſmell, and ſome other obvious and ſim-
als, will enable us to diſtinguiſh, whether the prin-
mineralizers be metals, ſulphuric ſalts, or calcareous
agneſian ſalts. If we deſire, merely to obtain that
, in a pure ſtate, which contains calcareous and ſul-
ſalts; ſimple boiling and cooling will—partly by
ration,—partly by depoſition, free the water which
bject to them, from calcareous mixtures. *Gaſ-*
en mineralizing water, will, with ſulphur and

whatever other ſubſtances may be ſuſpended in it, fly off upon mere expoſure to the external air. Even *ferruginous* mixtures are liable to ſeparate from water, by depoſition. It is leſs difficult to expel any mineralizer whatſoever from water, than to eſtimate accurately the proportions of ſuch mineralizers, while they are driven off.—To free water from a [illegible]ralizer, it may be proper to employ a pneu[illegible]cal apparatus. Put into this, any given quantity of [illegible] mineral water. Apply a temperature, ſufficient to evolve the gas, without evaporating the water. After obtaining the gas ſeparately, you may eaſily aſcertain by proper teſts, its peculiar nature. The compariſon of its quantity with the quantity of the water, will indicate the proportions of the mineralization. If other ſalts ſtill impregnate the remaining water, add, according to your judgment of the nature of theſe ſalts, thoſe ſubſtances which may be expected to attract them into new, precipitating compounds. If it be *iron* which you ſuſpect to mineralize your water, employ to detect and remove it, thoſe ſubſtances, ſuch as the Pruſſic Acid, the Gallic Acid, &c. which are well known to have the power of precipitating *iron* into new neutral combinations. If the mineral water which you ſubject to experiment, be ſuch, that you can form no conjecture of the nature of its mineralizers; then, try, firſt, the ſtrongeſt, and moſt general re-agents; varying in the uſe of theſe, till you ſhall, at laſt, fully detect the nature of the mineralizing principles, and aſcertain their proportions. The preferences of the reciprocal attractions of chemical ſubſtances, explained in the reſpective hiſtories of theſe ſubſtances, muſt be underſtood, in order to direct him who attempts the analyſis of mineral waters, in the uſe of the proper re-agents.

5. Formation of actitious mineral Waters.

There is no known mineral water which, in the preſent ſtate of the ſcience and practice of Chemiſtry, Art may not accurately imitate.

6. Medical uſe of mineral waters.

Mineral waters are certainly capable of being made uſeful for the cure of many diſeaſes. They ſerve as the beſt vehicles of both gazeous, fixed ſaline, and metallic remedies. But, we muſt confeſs, that, in the preſent ſtate of medicine, they are for the moſt part egregiouſly miſapplied; and that, in this miſapplication, they do more harm than good.

SECTION FIFTH.

cluſion.

1. Of the Ninth Book.

In the preceding ſections of this book, it has been endeavoured to exhibit a view of the beſt mode of applying Chemiſtry, after the reader is once acquainted, in a general manner, with its principles, to explain the phœnomena of inanimate nature, of vegetation, and of animal life, to improve the manipulations of the chemical arts, and to unfold the ratio by which the ſecret, unſeen parts of theſe manipulations naturally take place and form a connexion of the more obvious appearances. It is but a ſketch of any one of the chemical Arts which has been given: for, to have entered more fully into the detail of their practice, would have immeaſurably ſwollen out this volume; —it was properly, the chemical ratio alone, that we had to explain, and thoſe particulars ſolely of the actual mechanical practice, without which, the chemical ratio could not well be underſtood:—And beſides,—as this is a ſort of firſt attempt in the connecting of the explanation of the Arts;,—in ſuch a ſeparate and conſecutive mode, with the didactic deduction of ſcience;—the deſign was, rather to ſet an example of the beſt mode of teaching the chemical Arts which might be, hereafter, purſued to full improvement, than at once to accompl
poſſible, in this particular province.

2.
The Chemical Arts ſuſceptible of great Improvement.

One very pleaſing reſult eaſily appears from what has een here unfolded. Comparatively little, has been, hi-erto, done for the abbreviation and improvement of the emical Arts by means of Science. Almoſt all that has een done in theſe Arts, has ariſen in ſcientific error, in e imitation of practices which were ill-underſtood, in ſcoveries which originated in accident, and were taken p without enlightened intelligence. The abbreviations, e improvements, therefore, which the chemical Arts in ritain, may hereafter receive from Science, are more an can be eaſily conceived. From this quarter, much yet to be derived for the amelioration of the ſtate of cial life in Britain, for the increaſe of the wages of the bourers, for the reduction of the prices of goods in the arket, for the convenient multiplication of the numbers the inhabitants of our country.

3.
Cloſe of the Work.

WITH the cloſe of this Book, terminates the plan of is Work. To explain the Nature and Ends of Che-ical inveſtigation; to preſent ſuch a deſcription of the ſtruments and manipulations of the Laboratory, as, ough it could not ſerve to the ſtudent inſtead of actual, perimental acquaintance with theſe, might enable him to iew them at the firſt with more of intelligence than ere otherwiſe to be expected; to exhibit a ſcientific ar-ngement of the different parts of Chemiſtry; then to ive the Chemical Hiſtory of all the different ſubſtances nature, as nearly as poſſible in the order of the ſimplicity or the compound character of every reſpective body: and laſtly, to ſhew, in what manner, the knowledge of chemiſtry is to be applied to the general improvement of Art and Science; are all the objects to the accompliſhment of which the deſign and plan of this work have been directed. In the courſe of its execution, many of the mo[illegible]ble *deſiderata* in chemiſtry, have been neceſſarily [illegible]ed to attention. It is to be hoped, that, within the c[illegible]e of even a very few years,—the whole phaſes of this ſcience muſt be exceedingly changed by the rapid [illegible]ſs of chemical inveſtigation and diſcovery.

THE END.

APPENDIX FIRST.

OF PHLOGISTON.

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:MISTRY, till the ſeventeenth century, conſiſted
ıf a collection of facts, of which the ſecret rela-
were not explained by any grand principles of ra-
Science. Combuſtion, fuſion, evaporation, were
ecies of chemical phœnomena, the moſt conſtantly
obſervation in the Laboratory: And it was, there-
ıatural, that the firſt extenſive Chemical Theories
be framed to afford an explanation of the latent
on which thoſe phœnomena depended. *Beccher*,
ingly, propoſed the doctrine of the exiſtence of a
ır, *inflammable earth*,—the only combuſtible ſub-
in Nature,—entering, however, in various propor-
into all bodies ſuſceptible of combuſtion,—and con-
ıg in its various unions and modifications, the prin-
of ſmell, of ſpirituous action, and of all that is
arly refined and energetic in animal bodies, as well
their combuſtibility.

1. Beccher's inflammable earth.

STAHL

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2. Stahl's Phlogiſton.

STAHL, the deſciple of BECCHER, ſtrove to improve *his* doctrine, and to extend it, in its applications, to many new inſtances. He called this inflammable principle PHLOGISTON. He conſidered SULPHUR and the METALS, as the moſt eminently phlogiſtic among all phlogiſticated bodies. He thought, that METALS were combinations of EARTH with PHLOGISTON; and that calcination deprived them of their genuine metallic properties by extracting, in a ſort of combuſtion, the PHLOGISTON on which theſe had depended. In the caſe of the calcination of metals by *acids*, he believed, that the acids abſtracted the phlogiſton, and thus deſtroyed the metallic qualities of the ſubſtance calcined. He regarded Odorouſneſs, fuſibility, volatility, as properties little leſs inſeparable than inflammability, from the preſence of PHLOGISTON. He ſuppoſed alſo, that PHLOGISTON was the principle of colour in all bodies.

3. Diſciples of Stahl.

His principles were adopted by all other chemical philoſophers. While the Natural Philoſophers ſtrove to repreſent heat, as being ſimply a reſult from the inteſtine motion of the parts of bodies; it was, on the other hand conſidered by the Chemiſts, as a ſubſtance which was to be known, only in its combinations, and by its effects, and of which the qualities might not appear always the ſame, in every different body,—though it could not be doubted but a better acquaintance with the nature of all bodies, would explain the reaſon of their differences in phlogiſtic phœnomena. There was no better theory. Thoſe who laboured the moſt in Chemiſtry, were not philoſophers nor logicians, but mere workers in the laboratory,—empirics who thought nor of ſcientific order, but looked ſimply to appearances in what they performed, and nd were content with an imperfect theory, becauſe they ever examined, whether or not it were conſiſtent with tſelf. Even thoſe who attempted to philoſophize and to write, in Chemiſtry, long wanted facts from which they might deduce the proper principles. When the Chemiſts f Holland, of Pruſſia, of Sweden, of France, of Briain, wrote; in ſpite of the evidence of facts,—they wrote till rather to confirm than to queſtion the theory of HLOGISTON. Boerhaave, Neumann Lewis, Bergman, Macquer, Scheele, all agreed in maintaining the exiſtence f *phlogiſton.* In the reſearches into the Chemiſtry of irs by Hale, Prieſtly, and Cavendiſh, the general docrine of phlogiſton, was ſtill retained. Its elementary rincipals, entered not deeply into thoſe ſeries of experiments which they inſtituted: And they were, therefore, diſpoſed ather to overlook and conceal its incongruities, than to iew them in that ſtrong light in which they would have ppeared ſufficient to overturn and utterly explode the heory.

4. Inconſiſtency of the Phlogiſtic Theory.

But, in the mean time, a ſeries of not inconſiderable ifficulties were ſtill riſing more and more into view, the ore the applications of the theory of phlogiſton, began o be extended. *Charcoal,* one of the moſt entirely comuſtible of bodies, and by STAHL, conſidered, as little elſe an pure PHLOGISTON, was evidently neither odorous, olatile, nor fuſible,—though, if PHLOGISTON, it ought o have poſſeſſed theſe properties in the moſt eminent deree. *Diamond,* a body entirely combuſtible, without eſidue, was alſo, inodorous and infuſible. Spirit of ine, æther, and ſeveral of the eſſential oils, were courleſs. Moſt of the *metals,* when reduced into the ate of what was called calcination, aſſumed a deepneſs of of colour, by this fancied deprivation of PHLOGISTON, ſuch as according to the phogiſtic theory, ought rather to have owed to the preſence of PHLOGISTON. In many caſes, thoſe which the followers of STAHL called *dephlogiſticated* airs, were found to poſſeſs in greater ſhares than thoſe which were, in their opinion *phlogiſticated*, all the keener and finer energies of which PHLOGISTON was eſteemed the principle. In truth, this theory of phlogiſton gradually appeared to be an aſſemblage of contradictions, the moſt incongruous and irreconcileable that had ever yet been tenaciouſly maintained in ſcience. But it was deeply interwoven into the language of Chemiſtry: And Chemiſts had been ſo much accuſtomed to regulate their opinions in a conformity with its notions, that they would rather overlook its incongruities, than relinquiſh the accommodation which it had afforded them.

Facts which, at laſt, ſuggeſted a new theory.

At laſt, however, it was aſcertained, that bodies which had been hitherto ſuppoſed, in combuſtion, to give out PHLOGISTON, acquired an addition of weight by what was ſuppoſed to be the loſs of a principle. It was aſcertained at the ſame time, that the air in which this combuſtion took place, loſt as much of its former weight, by this act, as the burnt body gained: And it, farther, appeared, that air which had once in this manner contributed to combuſtion, till that combuſtion ſpontaneouſly ceaſed in it, could not again be made to aſſiſt a new combuſtion. From theſe facts, it was unavoidably inferred; that metals were originally ſimple, and became compounds only by combuſtion; that burning bodies, in general, loſt no principle by combuſtion, but in the act, abſtracted a new one from the air. The farther proſecution of this train of experiments confirmed thoſe inferences. It ap-

[illegible]

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peared, that, in what was called the calcination of metals by acids, the acids were decompoſed, and the calcined metals increaſed in weight by *their* decompoſition. It appeared, too, that thoſe which had been called *phlogiſticated* acids, were weaker and more impure than thoſe which had been called *Dephlogiſticated.*—Every fact, in ſhort, concurred to explode the notion of the exiſtence of ſuch a principle as *phlogiſton*, acting that part in nature which had been aſcribed to it. Its votaries made a ſtout reſiſtance. But, their oppoſition was at laſt overpowered, amidſt the abſurdities in which they ſaw themſelves entangled.

6. The new Theory.

But though PHLOGISTON or a principle of fire have been exploded from that place which it held in Chemiſtry, by the theory of STAHL; the exiſtence of ſuch a principle is ſtill univerſally confeſſed. It is now believed, that CALORIC,—HEAT,—or PHLOGISTON—if you chooſe to call it ſo,—is diffuſed throughout all nature. It is the principle by virtue of which, all bodies differ in denſity. Even in the denſeſt material bodies, there is perhaps a portion of expanding CALORIC or PHLOGISTON, by virtue of which, they are leſs denſe, than the unoppoſed attraction of gravitation, would otherwiſe, render them. The differences in denſity, of different ſolid bodies, depend upon their containing, reſpectively, more or leſs of PHLOGISTON. Matter is reduced into a liquid, by receiving into combination with it a much larger portion of *Caloric* or PHLOGISTON, than it requires to maintain it in a ſolid form. An addition of CALORIC or PHLOGISTON, much more conſiderable, expands matter into that which is called the gazeous ſtate. The lighteſt gaſes, are thoſe which contain the largeſt proportion of CALO-

RIC

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RIC or PHLOGISTON. Again, Combuſtion takes place whenever a ſubſtance in combination with *phlogiſton* or *caloric*, meets with any other ſubſtance, to combine with which it tends, in preference to remaining in union with its phlogiſton. Of all ſubſtances, that which is found the ofteneſt in a gazeous or eaſily decompoſible combination with phlogiſton, and has, at the ſame time, the ſtrongeſt tendency for combination with almoſt all other ſubſtances —is—OXYGEN. Combuſtion or the extrication of PHLOGISTON, is ſcarcely known to take place without a depoſition of oxygen from a liquid, a ſolid, or eſpecially a gazeous ſtate. Caloric, Phlogiſton, or Heat, never becomes preſent to our ſenſes, except when it is in the act of tranſition out of one combination to another. It is at all other times in combination. LIGHT, or that which is the medium of viſion, uſually accompanies it in all its combinations. Light and PHLOGISTON or CALORIC, united in a particular modification, conſtitute what is called ELECTRICITY.

7. Origin of the old Theory of Phlogiſton.

OF the old theory of PHLOGISTON, we can eaſily perceive, that it was a genuine progeny from the dreams of the Alchemiſts and Roſicrucians. It is in this manner, that advancing Science, firſt modifies, in all inſtances, the wild conceptions of fanciful ignorance. STAHL's *Phlogiſton*, BECCHER's *Inflammable Earth*, repreſent the *metallic Anima*, the *Panacean Virtue* of

hich had been ſuppoſed to poſſeſs the power of con-
erting, all baſer ſubſtances into gold, and of beſtowing
a man, immortal health and youth. A theory could not
ell be ſolid, which aroſe upon no ſurer baſis, than the
deavour to reconcile a vain fancy, to appearances to
hich it had no relation,—the endeavour to beſtow plau-
ility on that which its palpable abſurdity had begun to
prive of credit, even among the weakeſt of mankind.
is curious thus to trace the ſource of errour. It is
tereſting to remark, how truths ſhall, at times, be ſo
ilt around errour, as to give it an artificial ſtrength, and
their own injury, to protract its fall. It is not ſur-
iſing to find, even true philoſophers unwilling to re-
quiſh an errour, which has from their earlieſt youth,
ſociated itſelf with all their habits of marking, and all
eir ſcientific language.

APPENDIX SECOND.

OF THOSE NOTIONS OF THE DIVERSITIES OF GASES, WHICH WERE ENTERTAINED BY THE PHILOSOPHERS WHO FOUNDED THE ROYAL SOCIETY OF LONDON.

1. **Obſervation concerning Inventors in philoſophy.**

THOSE who make diſcoveries in Philoſophy, are wont to urge too high claims of originality; and to forget, in what manner, they were conducted by the ſuggeſtions of their predeceſſors, into thoſe trains of reaſoning by which they have been, in the end, led to diſcern the general truths of which they boaſt themſelves, the authors. They, again, who envy inventors in Philoſophy, the honour of their diſcoveries, are apt to attribute all to the ſcientific giants of a former age; and, if they can find, in old books, but a ſingle hint, however faint and obſcure, that relates to the ſubject of the modern diſcovery,—to pretend, that, from this, has the diſcoverer ſtolen all that he claims the merit of.

2. **Contention among chemiſts concerning the originality of the late diſcoveries.**

In the hiſtory of the new Diſcoveries in Chemiſtry, the operation of theſe principles is ſufficiently apparent. The Chemiſts of the School of LAVOISIER conſider themſelves, as the Creators of a New Science of Chemiſtry. Others pretend to have found out, that, in particular, an old Engliſh Chemiſt of the name of MAYO, had anticipated them in almoſt all that is eſſentially valuable in their diſcoveries. I am not inclined to agree-

: who would repreſent the modern diſcoveries
try, as originating ſolely from the unprompted
of LAVOISIER and his diſciples,—or with thoſe
the praiſe of the LAVOISIERIAN diſcoveries
iemiſts of a former age. But, I own, that,
id in Spratt's Hiſtory of the ROYAL SOCIETY
ON, the account of that Society's diſcoveries;
oniſhed, both, that this account has eſcaped
: of the late hiſtorians of Chemiſtry; and that
ries of LAVOISIER concerning gaſes, were not
ner added to thoſe which had become known
YAL SOCIETY OF LONDON, amidſt their firſt
exertions to perfect every Science, and to im-
ry branch of Art.—The following is the ac-
he diſcoveries of that illuſtrious body concern-
and AIRS,—as related by the eloquent SPRATT,
his work has proved himſelf, one of the beſt
at ever adorned any language.

8. Chemical Theories and experiments, related by SPRATT.

Experiments about Fire and Flame. Of theſe
were made, in order to the examination of a
propounded to them,—that there is no ſuch
as an elementary fire of the Peripatetics, nor
oms of the Epicureans; but that the fire is
act of the diſſolution of heated ſulphureous bodies
ir, as a menſtruum, much after the ſame manner
Fortis or any other ſharp menſtruums do work on
e bodies, as Iron, Tin, Copper; that Heat and
re two inſeparable effects of this diſſolution, as
d Ebullition are of thoſe diſſolutions of Tin and
; that, Flame is a diſſolution of Smoke which
of combuſtible particles, carried upward by the

Appen. II.

" at of rarefied air; and *that aſhes are a part of the*
" *ly, not diſſoluble by the Air.*

" Of this ſort, they have made experiments,—to find
" laſting of the burning of a candle, lamp, or coals,
" in a foot of c n, *rarefied*, and *condenſed* air;
" —to exhibit extinction of candles, lamps,
" and lighted c they are put into *ſatiated air*;
" —to ſhew the ſpeedy ction of kindled charcoals by
" blowing on them with bellows, that air which had,
" before, been ſatiated with burning;—to ſhew, that the
" greateſt and moſt laſting heat, without a ſupply of
" freſh air, is unable to burn wood, ſulphur and other
" combuſtible matters;—to find the comparative heat of
" all kinds of *fires* and *flames* of ſeveral materials, as of
" ſulphur, camphire, ſpirit of wine, oil, wood, coal, ſea-
" coal, iron;—to find, at what degree of heat,—lead, tin,
" ſilver, braſs, copper, gold—will melt.

* * * * * *

" Experiments of candles, and coals, extinguiſhed by
" the damps of a deep well;—of the burning of lamps
" under water;—of burning ſpirit of wine and camphire
" together, and the diverſity of their *flames*;—of reduc-
" ing copper to a very combuſtible ſubſtance;—of heat-
" ing the air by blowing it through a red-hot pipe, ſo
" as to burn wood;—of the brightneſs of the flame of
" nitre and ſulphur;—*of the burning and flaming of tin*
" *filings by the help of nitre***.*"

" ——— to make glaſs-bubbles ſwim in air very
" much condenſed;—of glaſs-balls riſing in a heavy
" or condenſed air, and falling in a
" rarefied."

"—— Of generating air by corroſive menſtruums out of fermenting liquors, out of water and other liquors by heat, and by exhauſtion;—of the returning of ſuch air into the water again;—of the vaniſhing of air into water exhauſted of air;—of the maintaining and increaſing a fire by ſuch airs;—of the fitneſs and unfitneſs of ſuch air for reſpiration;—of the uſe of air in breathing."——to try, how long a man can live by expiring and inſpiring again, the ſame air; to try, whether the air ſo reſpired, might not, by ſeveral means, be purified or renewed;—to prove, that it is not the cold nor the heat of this reſpired air that choaks."—

"——; of the quantity of freſh air requiſite for the life of a reſpiring animal;—of making air unfit for reſpiration, by ſatiating it, by ſuffering candles or coals to burn it, till they extinguiſh themſelves."

"Experiments of including living animals, and kindled coals, and candles in a large glaſs, to obſerve which of them will be firſt, extinguiſhed."—

"—— Of the living of creatures by factitious air*."

Whoever reads the detail of theſe experiments, muſt ſurprized, that, when the modern chemical diſcoveries are ſo nearly hit upon; the progreſs of that branch of ence ſhould have been interrupted, till ſo late a pe- id. But, in truth, the attention of Philoſophers was, on after, ſo entirely drawn by the extraordinary diſco-ries and inventions made in what is called Natural Phi-ophy, that the proſecution of chemical enquiries was, a great meaſure, forgotten. The alchemiſts had made the world ſick of the talk about Chemiſtry. And philoſophers were of conſequence, compelled to turn their regard upon ſomething that was leſs unpopular. Had it been otherwiſe; the labours of the founders of the Royal Society of London, muſt have anticipated the diſcoveries of Lavoiſier. Never did a company of Philoſophers with ſo much of generous ardour chaſtened by reaſon and common ſenſe, or with ſuch comprehenſive views of Science and of Art, enter upon the deſign of improving both Art and Science, in order to ameliorate the condition of human life. When we conſider, how much they did within a very few years, it is impoſſible, not to wonder, that ſo little ſhould have been ſince accompliſhed in the ſame tract of diſcovery. "Spratt's Hiſtory of the Royal Society"—is, in all reſpects, one of the nobleſt productions that any age or language can boaſt. It is the diſgrace of our country, that it has not paſſed through more than four editions, and that it is not, at preſent, more generally read.

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* Spratt's Hiſtory of the Royal Society, page 215 to 219.

APPENDIX THIRD.

OF COUNT RUMFORD'S THEORY, WHICH REPRESENTS WATER, AS A NON-CONDUCTOR OF HEAT.

1. Praiſe of Count Rumford's exertions.

EUROPE, and Britain in particular, owe much to the ingenious and patriotic labours and diſcoveries of Sir BENJAMIN THOMPSON, *Count* RUMFORD. Of the Philoſophers of the preſent age, I know not, that any one has laboured more diligently, or with better ſucceſs, to promote the application of the principles of Science, to improve the moſt uſeful arts of life. He has been eſpecially ſucceſsful in teaching a new œconomy in the uſe of fewel. He has, at the ſame time, propoſed a new doctrine in reſpect to the general nature and action of heat. This doctrine, I feel myſelf under a neceſſity of oppoſing.

2. His doctrine concerning Heat.

It is, if I rightly underſtand him; "That HEAT,—CALORIC,—or PHLOGISTON—as I have ventured to name it,—cannot paſs from one particle of water to another; that, in truth, heat is generated by friction for which it is impoſſible to account, otherwiſe than by ſuppoſing heat to be a mere modification of motion."

I think theſe doctrines very incorrect. I would explode them by the following reaſonings.

1. If water be a non-conductor of Heat, Caloric, or Phlogiſton; then Heat cannot paſs from one INDIVISI-

3. He miſtakes globules for indiviſible particles.

BLE PARTICLE of water to another. If it cannot paſs from one indiviſible particle of water to another; then nothing but an ELEMENTARY particle of water can ever be uniformly hot. A *globule* of water, uniformly hot, is a thing impoſſible. Except in indiviſible particles, water can have no part in the ordinary tranſmiſſions of heat. Unleſs in a minute ſubdiviſion in which we never behold it, water cannot enter into any of thoſe general phœnomena of the univerſe, in which it is accounted the moſt eminent and conſpicuous agent.

Riſum teneatis, amici?

But *Count* RUMFORD ſeems to have entered upon his experiments, without conſidering what a particle of water was, and to have thought, only of the ſmalleſt perceptible globule. He took a thing for granted, which was utterly incompatible with the truth of the theory which he was to build upon it. A globule of water was that portion of the fluid which he ſuppoſed to be incapable of communicating its heat to another globule. But, even a globule is itſelf, a collection, perhaps of millions of particles, amongſt which there muſt have been an intercommunication of heat, before the whole globule could be of one common temperature.

4. He miſrepreſents the action of Heat.

2. None of the experiments upon which Count RUMFORD and his followers have endeavoured to eſtabliſh their opinion, were conducted with due accuracy. They never conſidered, that, if they ſpoke at all, it was, only of an indiviſible particle of water, they ſhould ſpeak. While pretending their experiments with a vaſt parade of apparatus, and with great minuteneſs, they have always

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Appen. III.

eft many of the moſt important things, entirely out of onſideration. They have ſuppoſed, that heat or caloric ad a tendency to act downward equally ſtrong as its endency to act upwards; a thing perfectly contrary to ll ſcience and all experience; ſince the action of Heat or aloric or Phlogiſton is ever directly in oppoſition to ne gravitating action of other matter. They have uſed ſtrangely confuſed medley of the technical language of lectricity—which is, at beſt, highly improper,—with the anguage of Chemiſtry, and with that, yet more inaccuate, of common life.

5. Origin of the Heat from friction.

3. *Count* RUMFORD is much at a loſs—to underſtand —whence comes the heat that appears to be generated by iction?—He produces various experiments from which deciſively appears, that, even a *boiling heat* may be roduced by the friction of one ſolid metallic ſurface gainſt another. It is known, too, that burning and ame may be elicited by the long and violent rubbing of wo ſticks together. Experiments have been likewiſe ade by others from which it appears, that an extraorinary accumulation of heat may be commanded, even y friction *in vacuo*.

But, of all this, what is the genuine reſult? That a eſtruction of aggregation, extending even to the minuteſt olecules, contributes,—as mechanical agency always oes,—to ſome important chemical changes in the relaons between caloric and the ſubſtances containing it:

That, the attrition of which we here ſpeak, ſets at berty, all that Heat, Caloric, or Phlogiſton which was ontained in the aggregation of thoſe exceedingly minute articles which the friction divides:

[illegible]
[illegible]
[illegible]
tremely minute molecules, and to the fa
repreſs it from making its eſcape into th

That this ELASTICITY of heat is m
paring the liquefaction or gazifaction
quantity of any liquefiable or gazifiabl
from a given quantity of gas oxygen,
tion or gazification of the ſame quantity
ter by heat produced from the friction
and again by comparing the *bulk* of
—worn down by attrition, in producin
quantity of gazifaction—with the *bu*
which muſt neceſſarily be decompoſed,
the ſame quantity of gazifaction.

Does not the ſlaking of lime, equal
preſſibility of heat,—and evince; that, in
denſities, the compreſſions of the latent
—probably in the direct ratio—under co
—of the denſity of each body? The qua
out when lime, being ſlaked, attracts

takes place, in the firing of guns and artillery, and in all ſorts of exploſions with ſudden gazifaction.

1. If HEAT be merely MOTION; then ought the quantity of ſenſible heat to be always in proportion to the quantity of motion which is excited. But, the motions of the winds in the atmoſphere, infinitely exceed in quantity, whatever motion we can produce by friction. In the atmoſphere, then, according to *Count* RUMFORD's ſuppoſition, there could be nothing, in any region of it, but eternal flames and ſmouldering fires.

2. If HEAT be merely MOTION; then ought this Heat to be moſt ſtrongly perceptible to the human ſenſes, while the *motion* is continued. But, on the contrary, the human ſenſe feels it the moſt after the friction by which it was elicited, has pauſed.

3. If HEAT be merely MOTION; then ought motion always to increaſe and invigorate the action of Heat. On the contrary, the continued rubbing of two ſticks upon one another, will often extinguiſh that very flame which the previous rubbing of them together, had kindled. We ſee fires continually extinguiſhed by movements, but kindling up into lively flame and intenſity of Heat, in conſequence of being left at reſt, after the ſufficient quantity of kindling matter has been brought into due contact with the fewel with the acceſs of freſh air.

6. Doctrines inconſiſtent with Count Rumford's Theory.

4. Count Rumford's errors ſeem all to ariſe from inattention to theſe three undeniable, univerſally acknowledged doctrines:

1. That Heat, Caloric, or Phlogiſton is an elaſtic ſubſtance, ſuſceptible of compreſſion, and exiſting in greater compreſſion in the denſe than in the rare ſubſtances, which expands by a myſterious chemical union:

2. That,

2. That, HEAT, in circumſtances where it has equal acceſs, in both ways,—acts always in oppoſition to the gravitation of other matter toward the Earth's centre:

3. That, HEAT acting upon fluids placed above it, alters the ſpecific gravity of the parts of any fluid, which are the neareſt to it, faſter than thoſe parts can tranſmit their *ſurplus* heat to the parts the next above them; and thus produces thoſe appearances which have been aſcribed to the non-conducting nature of fluids in regard to heat.—*Count* RUMFORD has attributed more ordinary *mechanical* or *hydroſtatical* appearances to cauſes chemical or electrical.

It is impoſſible, here, to deſcend to all the detail of *Count* RUMFORD's experiments. But, the reader of Count RUMFORD's book, who carries in his mind, what has been here ſtated, and ſharply remarks, where there are or are not circumſtances overlooked in the Count's relations of his experiments, will eaſily ſee, that the facts afford no truely philoſophical foundation for the theory which their Author has endeavoured to eſtabliſh upon them.

5. Before cloſing this article, it may be proper to ſtate what ſeems to be the true ſcience relative to heat.—It is, as follows.

7. Science of Heat.

1. There are only two ſorts of matter in this whole terreſtrial ſyſtem;—one which gravitates from the Sun towards the centre of the Earth,—another which gravitates from the Earth towards the centre of the Sun. The *ſecond* of theſe is HEAT, CALORIC, or PHLOGISTON: The *firſt* comprehends all other ſorts of earthly matter.

2. The tendency of HEAT towards the Sun, produces the *centripetal* force of our planet: The oppoſite tendency of other matter, produces its centrifugal force.

3. Theſe two ſorts of matter are, by the laws of their combinations and diſunions, maintained in a conſtant equilibrium of their general energies.

4. If Heat were not combinable with other matter in perfect chemical union,—if it were not even more or leſs ſubject to mechanical agency; it would quickly eſcape entirely away to its proper centre, the Sun; and the preſent connexions and dependencies between the Earth and Sun would be of conſequence diſſolved.

5. HEAT, therefore, exiſts in combination with all ſorts of other matter In *gaſes*, the combination is the looſeſt and the moſt eaſily diſſoluble: In *fluids* it is ſomewhat leſs eaſily diſſoluble: In *ſolids*, it is not to be deſtroyed without a deſtruction of the ſolid aggregation, perhaps, even to the ſeparation of the minuteſt particles. The nature of the combination is conſiderably affected by the ſtate of the matter. In *gaſes*, there is an expanſion of the heat as of the gazeous baſis: In *liquids*, the HEAT, as well as the other matter, is more denſe: In *ſolids*, the compreſſion of the Heat is, again, exceedingly enhanced. That HEAT may be acted upon by mechanical agency, no perſon can doubt, who obſerves, how we confine it within walls, concentrate it by burning-glaſſes, accumulate it by reverberating furnaces. Theſe facts ſufficiently eſtabliſh the doctrine of its ELASTICITY. How, indeed, ſhould that be otherwiſe than ELASTIC, which is itſelf the grand cauſe of ELASTICITY, in all other material bodies? But, if the doctrine of the ELASTICITY and COMPRESSIBILITY of Heat, be once admitted; all

[illegible] difficulties concerning the production of Heat by [illegible], will find an eaſy ſolution.

6. HEAT is never *ſenſible*, unleſs in its tranſitions out of one combination into another. But, in certain hard and tenacious bodies, its paſſage out of one combination into another, is apt to be conſiderably retarded. *Cæteris paribus*, it will paſs f[illegible] ſenſible ſtate, more or leſs quickly, in the inverſe [illegible]ortion of the denſity of the medium preſented to it.

7. Bodies are, *cæteris* [illegible]*ibus*, more or leſs fit to be *Conductors of* HEAT, in [illegible]ortion, as they are, reſpectively, more or leſs ſuſce[illegible] of gazeous expanſion. Or rather, the *conducting power of bodies in reſpect to* HEAT, —is, in *the compound ratio* [illegible] *their expanſibility and their power of retaining* HEAT *by compreſſion.*

8. HEAT may be conſidered as the ſole univerſal ſolvent of all other bodies.

9. There are an infinite multiplicity of facts concerning HEAT, which remain ſtill to be inveſtigated.

APPENDIX FOURTH.

THAT LIME IS OXYGEN IN A CONCRETE STATE.

N the courſe of the laſt Book of the foregoing work, it s been thrown out, that LIME is nothing but OXYGEN a concrete ſtate. The following are the facts and ſug- ſtions, upon which that Opinion is founded.

1. Analogies.

I. All the late diſcoveries in Chemiſtry, lead us to re- rd the SOLID and the GAZEOUS ſubſtances as, in any inſtances, mutually convertible, by means of Heat, l the Gaſes are, either ſolitarily, or in compoſition, ncreſcible. *Diamond*, one of the moſt impenetrable bſtances with which we were acquainted, has been re- ntly found to be entirely gazefiable. There is ſcarcely y ſolid ſubſtance which may not be, either in combi- tion, or in ſuſpenſion, brought into a Gazeous form. is General analogy affords indeed no particular reaſon induce us to think Lime the baſis of GAS-OXYGEN; t it preſents a poſſibility which may induce us to give dit the more readily to any facts which ſhall ſeem to d to ſuch a general concluſion.

2. Bodies combuſtible and incombuſtible.

II. All the Bodies in Material Nature, may perhaps be ided into Bodies Combuſtible and Bodies Incombuſtible, Matters capable of entering into direct combination with ygen,—And Matters which are not ſuſceptible of any h union. Now, the only bodies which can be conſidered

Appen. IV. ſidered as *Incombuſtible* or *Unoxygenable*,—are,-
Potaſh, Soda, the Earths-Alumina—Silice—and th
Earths more rarely met with, but diſtinguiſhed a
liar by the qualities and figures of the neutral ſa
which they enter.

3. Agencies of Lime, ſimilar to thoſe of oxygen.

III. Whatever we ſay of the other ſubſtance
ſhall perhaps find it difficult to conclude of Lime,
and Soda, that they are Unoxygenable, in conſequ
any contrariety of nature to Oxygen. LIME in
cular, appears often to act nearly the ſame part i
binations, as OXYGEN. *Lime-water* has much
agency of an acid. It can hardly be doubted, bu
produces Carbonic Acid from Carbon, juſt as do
buſtion. Clothes are whitened, in bleaching, by the
of Lime, juſt as by that of Oxygen. The reſiſta
Lime to the action of fire, ſtrongly reſembles that
Oxygenated ſubſtance. In its ſepticity in certain
and its antiſepticity in ſome others, Lime has an
remarkably ſimilar to that of Oxygen and the com
into which it enters.

4. An animal wax formed with Lime.

IV. We know, that *vegetable reſins*,—that, *ſpe*
from the head of the whale, which has a conſid
analogy to vegetable reſins,—that, the *factitious ſpe*
which it has been lately found poſſible to procure b
jecting the muſcular ſubſtance of animal bodies
action of running water, and by raiſing, after a c
time, the remains of animal bodies, from the gra
certain burying grounds,—that theſe ſubſtances con
hydrogen and carbon with perhaps ſome ſmall rem
of azote, and with an addition of Oxygen.

Now, from the experiments of Mr. CROOKS of
burgh, it appears, that the bodies of herrings and

f

ſhes, treated with Lime, afford a ſort of animal reſin, not unlike to wax, and certainly conſiſting of hydrogen and carbon with an addition of Oxygen,—a ſubſtance, in ſhort, which is adapted to ſecure many of the purpoſes of wax or ſpermaceti. How could ſuch a ſubſtance be produced by merely treating the bodies of fiſhes with quicklime,—unleſs quicklime were, in certain circumſtances, convertible into Oxygen?

5. Lime of animal and vegetable bodies.

V. Much Quicklime is produced in the bodies of *Animals*, and in *Vegetables*; yet we do not know, that either Quicklime or Calcareous ſalts of any ſort, are, ordinarily, taken, as nouriſhment, into either the one or the other. The ſhells of marine Animals are ſo remarkably *calcareous*, that many ingenious philoſophers have conjectured calcareous matters in general, to derive their origin ſolely from the operation of the organic functions of theſe and other animals. Lime is the baſis of animal bones. It enters as an ingredient into the urine of moſt animals. It is, in ſuch, ſo eminently an animal product, that there is not, at this moment, a doubt among philoſophers, *but there is a primary production of* LIME, *by the organic functions of animals, in general.*

Now, if there be a primary production of LIME under the organic functions of animals; theſe functions muſt,—either—create it from nothing,—or elſe, extract or modify it from ſome ſubſtance which is brought under them either by *abſorption* at the ſkin, by *inhaling* into the lungs, or by *ſwallowing* into the ſtomach. All the ſubſtances which animals, in any manner, take in, as aliments, are ſubject to be ultimately reſolved into *oxygen*, *carbon*, *hydrogen*, and *azote*, with perhaps ſome *acid-baſis* and ſome occaſional portions of alkali. The acid-baſis and

the

Appen IV.

the alkali are traced in the excrements, in the ſecretions at the ſkin, or in the permanently fixed parts of the animal bodies. *But, if we conſider what a quantity of Oxygen, men and other animals take into their bodies as nutriment, and by fixation at the lungs, as well as by abſorption at the ſkin; we ſhall find it to be much more, than can either be fixed or carried off by the known ſecretions—unleſs it be in part, fixed and concreted in the Lime of the bones.* If, again, we conſidet,—how vaſt the difference in bulk between the ſame quantity of Oxygen when it is in Gas, and when it is in a ſtate of concretion; we ſhall be eaſily ſatisfied, that the portion of the Oxygen taken into the animal frame, of which the conſumption cannot be otherwiſe accounted for, is *exactly* taken up in the formation of the bones and the oſſeous part of the excrement. The Azote, the hydrogen, the carbon which we, in various ways, take into the body, are wholly either fixed or ſecreted in excrement, in a manner which we can ſufficiently underſtand, and accurately eſtimate. Beſides, of the nature of every one of theſe three ſubſtances we know enough to be ſatisfied that Lime cannot be formed by the concretion of any one of *them*. There remains then, only the *Oxygen*, to the concretion of which, the origin of the *Lime* in the bones can be referred.

6. Operation of Lime as a manure.

VI. *Lime* operates, with wonderful force, as a manure, to quicken vegetation, and to fertilize ſoils that might, otherwiſe, prove barren. Many theories have been at different times, offered, to account for the fertilizing powers of Lime. None of them has been found ſatisfactorily to agree with the phœnomena. Its ſepa deſtruction of other vegetables than thoſe which it is to nouriſh; its power to abſorb ſuperfluous moiſture; its

formation

n of neutral ſalts ſupplying azote or carbon; are
rly inadequate to explain its extraordinary fertili-
rgies. Nothing but Oxygen ſupplied in extraor-
abundance, and yet with a proper intermixture of
elements could contribute to promote vegetation
anner in which Lime always promotes it. We
the rather inclined to entertain this opinion,—if
t that the *growth* of vegetables is, chiefly, a pro-
radual *Oxygenation*,—and their ripening, again, a
f *de-oxygenation*. Is it not, then, probable, that
which ſo eminently promotes vegetation, paſſes
vegetables, as a principle, and in paſſing into
by the functions of vegetative life, reſolved into

Beſides, the atmoſphere over ſtrata of Limeſtone,
that ſalutarineſs, which is only to be expected,
ere is commonly an extraordinary proportion of
gen or *vital air*. A *Dr.* MITCHELL of New
midſt ſome very inaccurate chemical notions, has,
it juſtice, repreſented the uſe of *Limeſtone* in pa-
ſtreets, in building &c. as, tending to prevent
tion of the yellow fever, and of whatever other
riginate in a deficiency of Gas-Oxygen. But, it
ible, that Lime ſhould by any of its other known
accompliſh ſuch an effect,—unleſs by an inſen-
verſion of it into Gas-Oxygen.

The origin of the Fixed Alkalis is conſiderably
s to what is here repreſented concerning Lime.
ceſſary to repeat, in how many of their qualities,
coincidence of Nature between Lime and theſe
They are, all equally *incombuſtible*, &c. Now,
ely know of any fixed Alkali, whether ſoda or

Appen.IV. potaſh, which has not its origin under the functions [illegible] vegetation. It *muſt*, of courſe, be a product elabor[illegible] from Hydrogen; Carbon, Oxygen, or Azote, the [illegible]ments of vegetable ſubſtance, either ſeparately in [illegible] combination. If either Carbon, Hydrogen, or Azote were the element from which the alkali of vegetables, is elaborated; then muſt this alkali retain ſo much of the nature of the element from which it was produced, as to be *deſtructible by fire*. But, neither ſoda nor potaſh is known to be deſtructible by fire. We may, therefore, infer that neither the one nor the other has its formation from Hydrogen, Carbon, or Azote. There remains, only Oxygen. Can it be unreaſonable to conclude, that the Fixed Alkalis are, as well as Lime, particular, concrete modifications of this ſame ſubſtance?

IX. In the whole, this body of facts,—facts which have, in their favour, not the force, ſimply of one or two experiments, but of a moſt extenſive and unqueſtionable experience;—are, indeed, ſufficient to render it exceedingly probable, that Lime and the two Fixed Alkalis are but different modifications of Oxygen reduced into a concrete ſtate; yet do not fully eſtabliſh this, as elementary ſcientific truth.

It is, however, probable that, if a mixture of LIME with *ſulphur*, *carbon*, *phoſphor*, or hydrogen, might be expoſed to the utmoſt poſſible intenſity of Heat for a very long ſpace of time; the truth of this matter, would, then, be finally and deciſively aſcertained. If Lime be, indeed, only Oxygen in a peculiar ſtate; then would ſulphuric acid, carbonic acid, phoſphoric acid, or water, be ultimately produced in ſuch an experiment. If, on the other

hand,

ne be not a concrete modification of Oxygen; Appen. IV.
ld no ſuch products be, thus, obtained.
he Fixed Alkalis, ſimilar experiments might be
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